United States Department of Agriculture

DRAFT Environmental Impact Statement

Resolution Copper Project and Land Exchange

Volume 1

Forest Service | Tonto National Forest | MB-R3-12-07 | August 2019

Front Cover photo captions:
Top: Oak Flat Federal Parcel
Bottom Left: Oak Flat Federal Parcel
Bottom Right: Headframe of Shaft 10 at East Plant Site

Back Cover photo captions:
Top left: Shaft 9 and 10 at East Plant Site
Top center: MARRCO corridor
Top right: Picket Post mountain
Bottom left: Oak Flat Federal Parcel
Bottom right: Overlooking West Plant Site, Town of Superior and Picket Post mountain

USDA United States Department of Agriculture | Forest Service | Tonto National Forest

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File Code: 2800; 5590; 1910
Date: August 1, 2019

Dear Reader:

The USDA Forest Service is pleased to announce the Draft Environmental Impact Statement (DEIS) for the Resolution Copper Project and Land Exchange, along with supporting documents, are available for public review and accessible online at www.ResolutionMineEIS.us.

As the lead agency for this project, the Tonto National Forest invites the public to comment over a 90-day period—**August 10 through November 7, 2019**—on the environmental review and analysis findings for the operation of a proposed underground copper mine; a connected, Congressionally mandated land exchange; and related project-specific forest plan amendments. We appreciate comments that are specific to the proposal and include supporting reasons for us to consider.

Resolution Copper Mining, LLC (Resolution Copper) proposes developing an underground copper mine on unpatented mining claims on National Forest System (NFS) lands near Superior, Arizona. To access the copper deposit, located primarily on NFS lands, Resolution Copper pursued a land exchange.

In December 2014, Congress authorized a land exchange pending completion of an Environmental Impact Statement, as outlined in Section 3003 of the National Defense Authorization Act (NDAA) for fiscal year 2015. The exchange parcel to be conveyed to Resolution Copper includes not only the Oak Flat Withdrawal Area but also the NFS lands above which the copper deposit is located. This collective 2,422-acre tract of land is known as the "Oak Flat Federal Parcel." Resolution Copper would, in turn, exchange eight parcels located throughout Arizona (5,376 acres of private land) to the Federal Government.

On behalf of the Secretary of Agriculture, the Tonto National Forest is responsible for preparing a single Environmental Impact Statement to: approve a mining general plan of operations submitted by Resolution Copper; and facilitate a land exchange of the Oak Flat Federal Parcel (2,422 acres of NFS land) for eight parcels located throughout Arizona (5,376 acres of private land currently owned by Resolution Copper) as directed by Section 3003 of the NDAA for 2015.

We prepared this DEIS in compliance with the National Environmental Policy Act (NEPA) and other relevant Federal and State laws and regulations. This DEIS discloses the direct, indirect, and cumulative environmental impacts that would result from the proposed action (described above) and alternatives.

Chapter 1 of the DEIS provides greater detail regarding the purpose of and need for action. It describes the framework in which decisions will be made, and the significant issues associated with the proposed action. Chapter 2 outlines alternatives. It describes the proposed action, four additional action alternatives, and our preferred alternative. The third chapter describes the affected environment and the environmental consequences associated with the proposed action and the alternatives. Appendix J contains descriptions of mitigation concepts being considered and known to be effective at reducing adverse impacts of the mine proposal.

Since 2016, public and partner involvement has played a critical role in helping the Tonto National Forest develop the project components. Public comments submitted during the scoping period in spring 2016 formulated issues concerning the proposed action. Issues help set the scope of the actions, alternatives, and effects to consider in our analysis. Seven social and cultural issues along with seven physical and biological issues were carried forward for analysis in the DEIS.

How to Submit Comments

There are several ways to submit comments, you only need to provide your comment once for it to receive full consideration:

- Attend an open house public hearing (see schedule below for public hearing dates and times)
- Submit a comment using the online form at: www.ResolutionMineEIS.us/Comment. The online form accepts attachments in Microsoft Word (.doc and .docx), rich-text format (.rtf), plaintext (.txt), or portable document format (.pdf)
- Submit written comments via U.S. Postal Service mail to:

  Resolution EIS Comment
  PO Box 34468
  Phoenix, AZ 85067-4468
  NOTE: Written comments and statements must be postmarked no later than November 7, 2019.

Please include your name, address, and affiliation (if any). Be advised that your entire comment, including your personal identifying information, may be made publicly available. Although you may ask us in your comment to withhold your personal identifying information from public review, we cannot guarantee that we will be able to do so. All submissions from organizations and businesses, and from individuals identifying themselves as representatives or officials of organizations or businesses, will be available for public review in their entirety.

Public Meeting Schedule

September 10, 2019, 5 to 8 p.m.
Superior Jr./Sr. High School Cafeteria
1500 Panther Drive
Superior, AZ

September 12, 2019, 5 to 8 p.m.
Central Arizona College
3736 E. Bella Vista Road
San Tan Valley, AZ

September 17, 2019, 5 to 8 p.m.
Ray Elementary School Cafeteria
701 AZ-177
Kearny, AZ

September 19, 2019, 5 to 8 p.m.
High Desert Middle School Auditorium
4000 High Desert Drive
Globe, AZ

October 8, 2019, 5 to 8 p.m.
Queen Valley Community Center
1464 E. Queen Valley Drive
Queen Valley, AZ

After the 2019 comment period, the Forest Service will review and respond to comments it receives. This comment response will be in an appendix to the Final EIS. The Forest Service will then finalize the EIS and issue a draft Record of Decision (ROD), which will document the alternative selected for the mine General Plan of Operations and the necessary project-specific forest plan amendments. We anticipate this occurring in summer 2020. This draft ROD will be subject to an administrative review process (also known as the objection process), pursuant to 36 CFR part 218. Upon completion of the objection process, a final ROD will be issued, anticipated to occur in winter 2020/2021. The Land Exchange will be fully executed no later than 60 days after the release of the Final EIS.

Sincerely,

NEIL BOSWORTH
Forest Supervisor

Resolution Copper Project and Land Exchange

Draft

Environmental Impact Statement

Pinal County, Arizona
August 2019

Lead Agency:	**USDA Forest Service**
Cooperating Agencies:	**Arizona Department of Environmental Quality, Arizona Department of Water Resources, Arizona Game and Fish Department, Arizona State Land Department, Arizona State Mine Inspector, Bureau of Land Management, Pinal County Air Quality Control District, U.S. Army Corps of Engineers, U.S. Environmental Protection Agency**
Responsible Official:	**Neil Bosworth, Forest Supervisor** **2324 East McDowell Road, Phoenix, AZ 85006**
For Information, Contact:	**John Scaggs, Public Affairs Specialist** **2324 East McDowell Road, Phoenix, AZ 85006**

Abstract: The purpose of and need for the environmental impact statement includes evaluating the impacts associated with approval of a mine plan, and considering the effects of the exchange of lands between Resolution Copper Mining, LLC, and the United States as directed by Section 3003 of the Carl Levin and Howard P. 'Buck' McKeon National Defense Authorization Act for Fiscal Year 2015 (NDAA).

The analysis includes six alternatives: the proposed action, which calls for a new underground mine underneath Oak Flat east of Superior, Arizona, and a tailings storage facility on National Forest System (NFS) lands west of Superior; a no action alternative under which neither the land exchange nor the mine plan would be authorized; an alternative that would allow a modified tailings disposal method at the same Near West tailings storage location as proposed; an alternative that would allow filtered tailings to be stored at another location on NFS lands north of Superior; and two alternatives that would not allow tailings to be stored on NFS lands, but on other agency or private lands. The scoping process identified water quantity, water quality, public health and safety, cultural resources, tribal concerns, and recreation as significant issues.

It is important that reviewers provide their comments at such times and in such a way that they are useful to the Agency's preparation of the EIS. Therefore, comments should be provided prior to the close of the comment period and should clearly articulate the reviewer's concerns and contentions. The submission of timely and specific comments can affect a reviewer's ability to participate in subsequent administrative review or judicial review. Comments received in response to this solicitation, including names and addresses of those who comment, will be part of the public record for this proposed action. Comments submitted anonymously will be accepted and considered; however, anonymous comments will not provide the respondent with standing to participate in subsequent administrative or judicial reviews.

Send Comments To:	**Resolution Copper EIS** **P.O. Box 34468** **Phoenix, AZ 85067-4468**
Date Comments Must Be Received:	**November 7, 2019**

ES-1 INTRODUCTION

This executive summary provides an overview of the draft environmental impact statement (DEIS) for the proposed Resolution Copper Project and Land Exchange (herein called the project). The purpose of the DEIS is to describe the process undertaken by the U.S. Forest Service (Forest Service), a land management agency under the U.S. Department of Agriculture, to evaluate the predicted effects of and issues related to the submittal of a mining General Plan of Operations (GPO) by Resolution Copper Mining, LLC (Resolution Copper), along with a connected, legislatively mandated land exchange of Federal and private parcels in southeastern Arizona (figure ES-1).

This Executive Summary does not provide all details contained in the DEIS. Please refer to the DEIS, its appendices, or referenced reports for more information. The DEIS and supporting documents are available on the project website at https://www.ResolutionMineEIS.us/.

ES-1.1 Background

Resolution Copper proposes developing an underground copper mine on unpatented mining claims on National Forest System (NFS) land near the town of Superior in Pinal County, Arizona, approximately 60 miles east of Phoenix. Resolution Copper is a limited liability company that is owned by Rio Tinto (55 percent) and BHP (45 percent). Rio Tinto is the managing member.

Resolution Copper has ties to the century-old Magma Mine located in Superior, Arizona. The Magma Mine began production in 1910. In addition to constructing substantial surface facilities in Superior, the Magma Mine created approximately 42 miles of underground workings.

In 1995, the Magma Copper Company discovered a copper deposit about 1.2 miles south of the Magma Mine through exploration of those underground workings. The ore deposit lies between 4,500 and 7,000 feet below the surface.

In 1996, BHP Copper, Inc., acquired the Magma Copper Company, along with the Resolution Copper Mine deposit. Later that year, BHP closed operations at the Magma Mine, but exploration of the copper deposit continued.

In 2001, Kennecott Exploration, a subsidiary of Rio Tinto, signed an earn-in agreement with BHP, and initiated a drilling program to further explore the deposit. Based on drilling data, officials believe the Resolution Copper Mine deposit to be one of the largest undeveloped copper deposits in the world, with an estimated copper resource of 1,970 billion metric tonnes at an average grade of 1.54 percent copper.

The portion of the Resolution Copper Mine deposit explored to date is located primarily on the Tonto National Forest and open to mineral entry under the General Mining Law of 1872. The copper deposit likely extends underneath an adjacent 760-acre section of NFS land known as the “Oak Flat Withdrawal Area.” The 760-acre Oak Flat Withdrawal Area was withdrawn from mineral entry in 1955 by Public Land Order 1229, which prevented Resolution Copper from conducting mineral exploration or other mining-related activities. Resolution Copper pursued a land exchange for more than 10 years to acquire lands northeast of the copper deposit.

In December 2014, Congress authorized a land exchange pending completion of the environmental impact statement (EIS), as outlined in Section 3003 of the Carl Levin and Howard P. ‘Buck’ McKeon National Defense Authorization Act for Fiscal Year 2015 (NDAA) for fiscal year 2015. The exchange parcel to be conveyed to Resolution Copper includes not only the Oak Flat Withdrawal Area but also the NFS lands above which the copper deposit is located. This collective 2,422-acre tract of land is known as the “Oak Flat Federal Parcel.”

ES-1.2 Project Overview

Resolution Copper is proposing to develop an underground copper mine at a site in Pinal County, about 60 miles east of Phoenix near Superior, Arizona. Project components include the mine site, associated infrastructure, a transportation corridor, and a tailings storage facility.

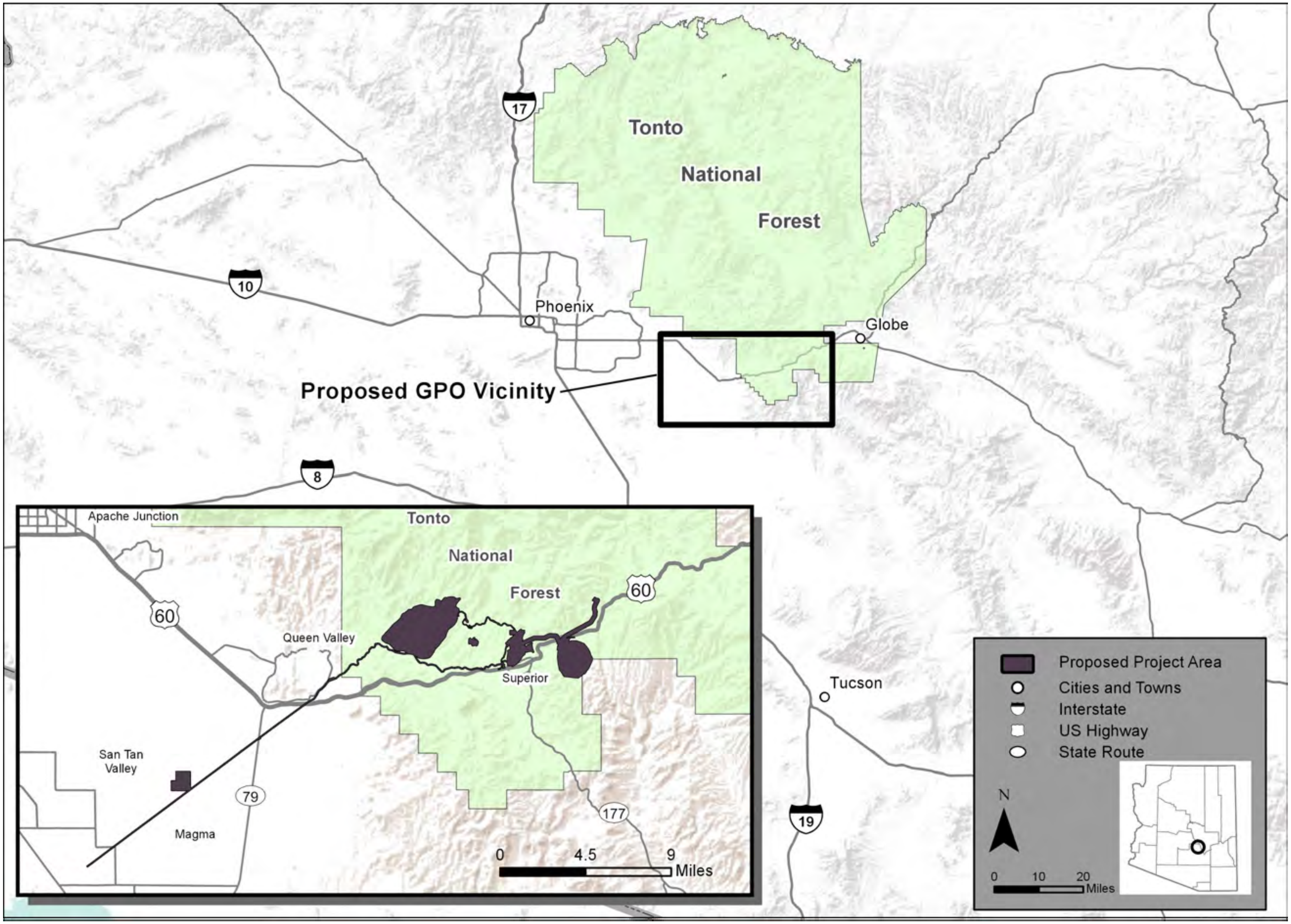

Figure ES-1. Resolution Copper Project vicinity map

The project would progress through three distinct phases: construction (10 years), operations, also referred to as the production phase (40–50 years), and reclamation (5–10 years). At the end of operations, facilities would be closed and reclaimed in compliance with permit conditions.

Operational projections are removal of 1.4 billion tons of ore and production of 40 billion pounds of copper using a mining technique known as panel caving. Using this process, a network of shafts and tunnels is constructed below the ore body. Access to the infrastructure associated with the panel caving would be from vertical shafts in an area known as the East Plant Site, which would be developed adjacent to the Oak Flat Federal Parcel. This area would include mine shafts and a variety of surface facilities to support mining operations. This area currently contains two operating mine shafts, a mine administration building, and other mining infrastructure. Portions of the East Plant Site would be located on NFS lands and would be subject to Forest Service regulatory jurisdiction. Ore processing would take place at the old Magma Mine site in Superior.

Construction of a tailings storage facility would house the waste material left over after processing. The facility footprint would occupy from 2,300 to 5,900 acres, depending on the location and embankment design. Pipelines would be constructed to transport the tailings waste from the ore processing facility to the tailings storage facility.

The estimated total quantity of external water needed for the life of the mine (construction through closure and reclamation) is substantial and varies by alternative (180,000 to 590,000 acre-feet). Resolution Copper proposes to use water either directly from the Central Arizona Project (CAP) canal and/or groundwater pumped from the East Salt River valley. Over the past decade, Resolution Copper has obtained banked water credits for recharging aquifers in central Arizona; the groundwater pumped would be recovery of those banked water credits, or groundwater use authorized by the State of Arizona under a mineral extraction withdrawal permit.

While all mining would be conducted underground, removing the ore would cause the ground surface to collapse, creating a subsidence area at the Oak Flat Federal Parcel. The crater would start to appear in year 6 of active mining. The crater ultimately would be between 800 and 1,115 feet deep and roughly 1.8 miles across. The Forest Service assessed alternative mining techniques in an effort to prevent subsidence, but alternative methods were considered unreasonable.

The workforce during construction/ramp-up is expected to peak at 2,600 personnel in Pinal County and another 1,900 in other areas. During operations, the project would employ an average of approximately 1,900 people annually in Pinal County and another 1,800 in other areas. During the reclamation phase, employment is projected to be 1,700 in Pinal County and 1,300 in other areas.

ES-1.3 Areas of Controversy

The Resolution Copper Project and Land Exchange is controversial for several reasons.

Foremost among them are the expected significant environmental impacts and loss of the Oak Flat area, historically used by Native Americans who hold the land as sacred and use the area for spiritual and traditional uses. Additionally, in March 2016, the Oak Flat area was listed on the National Register of Historic Places (NRHP) as a traditional cultural property (TCP).

There is the potential for some portion of existing yet currently unidentified prehistoric and historic artifacts and resources to be disturbed or destroyed, especially within the Oak Flat subsidence area and the footprint of the tailings storage area. These losses could potentially include human burials within these areas.

Water use is a major concern among the public, other government agencies, and stakeholders. Recycling and reuse would happen extensively throughout the mine operations, but as previously mentioned, additional external water is needed for processing.

There are concerns regarding how public safety may be affected by the project. This includes the physical safety of persons in areas of subsidence and adjacent communities, as well as increased traffic and effects on air and water quality.

There is public apprehension over the creation, and type, of a tailings embankment for the tailings storage facility. The catastrophic collapse of the Brumadinho tailings dam in Brazil in January 2019, resulting in over 100 fatalities, has heightened concerns.

In January 2019, Representative Raul Grijalva, a Democrat from Arizona, and Senator Bernie Sanders, an Independent from Vermont, introduced legislation that would overturn the land exchange described in Section 3003 of the NDAA. Representative Grijalva cited the need to protect Oak Flat and restore some balance to the country's natural resource policies.

ES-1.4 Lead and Cooperating Agency Roles

In compliance with the National Environmental Policy Act (NEPA), the Forest Service is the lead agency preparing this EIS. The Forest Supervisor, Tonto National Forest, is the primary deciding official for the proposed mining plan of operations submitted by Resolution Copper.

The Forest Service's role as lead agency includes the following:

- Analyzing and disclosing environmental effects of the proposed mine and the land exchange on private, State, and NFS lands or other Federal lands
- Conducting government-to-government consultations with potentially affected Indian Tribes
- Developing mitigations to protect surface resources of the Tonto National Forest and recommending mitigations for lands not under Forest Service jurisdiction

Authorization of more than 25 permits and plans from various jurisdictions are required for this mine project. Representatives from Federal, State of Arizona, and county governments are serving as cooperating agencies with the Forest Service in developing this EIS. Cooperating agencies have jurisdiction over some part of the project by law or have special expertise in the environmental effects that are addressed in the EIS. Monthly calls and meetings between the lead and cooperating agencies have occurred since November 2017. The nine cooperating agencies are as follows:

- U.S. Army Corps of Engineers (USACE)
- U.S. Department of the Interior Bureau of Land Management (BLM)
- U.S. Environmental Protection Agency
- Arizona State Land Department
- Arizona Department of Environmental Quality
- Arizona Department of Water Resources
- Arizona Game and Fish Department
- Arizona State Mine Inspector
- Pinal County Air Quality Control District

Pursuant to Section 404 of the Clean Water Act, Resolution Copper has asked for authorization to discharge fill material into waters of the U.S. for the construction of a tailings storage facility at certain proposed locations. Because Congress directed that a single EIS is to support all Federal decisions related to the proposed mine, the USACE is relying on this EIS to support a decision for issuance of a Section 404 permit.

The 404 permitting process includes Resolution Copper's submittal of a document called a "404(b)1 alternatives analysis" to USACE. The purpose of the 404(b)1 alternatives analysis is to identify the least environmentally damaging practicable alternative. Part of USACE's permitting responsibility is to identify the least environmentally damaging practicable alternative, as well as to require adequate mitigation to compensate for impacts to waters of the U.S.

While most of the impacts considered under the USACE process are identical to those considered in this EIS, some impacts considered under the USACE process are specific only to that permitting process, which may have a different scope of analysis than the EIS. Because of these

differences, the 404(b)1 alternatives analysis is a document strongly related to the EIS, but also separate.

Accordingly, the 404(b)1 alternatives analysis is attached to the EIS as appendix C.

ES-1.5 Purpose and Need

The purpose of and need for this project is twofold:

1. To consider approval of a proposed mine plan governing surface disturbance on NFS lands—outside of the exchange parcels—from mining operations that are reasonably incident to extraction, transportation, and processing of copper and molybdenum.
2. To consider the effects of the exchange of lands between Resolution Copper (roughly 5,376 acres of private land on eight parcels located throughout Arizona) and the United States (2,422 acres forming the Oak Flat Federal Parcel) as directed by Section 3003 of the NDAA.

The role of the Forest Service under its primary authorities in the Organic Administration Act, Locatable Minerals Regulations (36 Code of Federal Regulations [CFR] 228 Subpart A), and the Multiple-Use Mining Act is to ensure that mining activities minimize adverse environmental effects on NFS surface resources and comply with all applicable environmental laws. The Forest Service may impose reasonable conditions to protect surface resources.

Through the Mining and Mineral Policy Act, Congress has stated that it is the continuing policy of the Federal Government, on behalf of national interests, to foster and encourage private enterprise in

- development of economically sound and stable domestic mining, minerals, and metal and mineral reclamation industries; and
- orderly and economic development of domestic mineral resources, reserves, and reclamation of metals and minerals to help ensure satisfaction of industrial, security, and environmental needs.

Secretary of Agriculture regulations that govern the use of surface resources in conjunction with mining operations on NFS lands are set forth under 36 CFR 228 Subpart A. These regulations require that the Forest Service respond to parties who submit proposed plans to conduct mining operations on or otherwise use NFS lands in conjunction with mining for part or all of their planned actions.

Compliance with other laws and regulations, such as State of Arizona water and air regulations, the Endangered Species Act, the Clean Water Act, and the National Historic Preservation Act (NHPA), also frames the proposed mining activities.

ES-1.6 Proposed Action

The proposed action consists of (1) approval of a mining plan for operations on NFS lands associated with a proposed large-scale mine, which would be on private land after the land exchange, (2) the NDAA-directed land exchange between Resolution Copper and the United States, and, if needed, (3) amendments to the Tonto National Forest Land and Resource Management Plan (forest plan). The next two sections summarize the proposed GPO and the land exchange actions.

ES-1.6.1 General Plan of Operations

A detailed description of the GPO can be found in section 2.2.2.2. The complete GPO is available on the project website, www.ResolutionMineEIS.us.

The type of copper deposit that would be mined at the East Plant Site is a porphyry deposit, a lower-grade deposit that requires higher mine production rates to be economically viable. The copper deposit that

Resolution Copper proposes to mine averages 1.54 percent copper (i.e., every ton of ore would on average contain 31 pounds of copper).

Mined ore would be crushed underground and then transported underground approximately 2.5 miles west to an area known as the West Plant Site, where ore would be processed to produce copper and molybdenum concentrates. Portions of the West Plant Site would be located on NFS lands and would be subject to Forest Service regulatory jurisdiction.

Once processed, the copper concentrate would be pumped as a slurry through a 22-mile pipeline to a filter plant and loadout facility located near Florence Junction, Arizona, where copper concentrate would be filtered and then sent to off-site smelters via rail cars or trucks. The molybdenum concentrate would be filtered, dried, and sent to market via truck directly from the West Plant Site.

The copper concentrate slurry pipeline corridor would be located along an existing, previously disturbed right-of-way known as the Magma Arizona Railroad Company (MARRCO) corridor. The MARRCO corridor would also host other mine infrastructure, including water pipelines, power lines, pump stations, and groundwater wells. A portion of the MARRCO corridor is located on NFS lands and would be subject to Forest Service regulatory jurisdiction.

Tailings produced at the West Plant Site would be pumped as a slurry through several pipelines for 4.7 miles to a tailings storage facility. The tailings storage area would gradually expand over time, eventually reaching about 3,300 acres in size. A fence constructed around the tailings to exclude public access would enclose approximately 4,900 acres. The proposed tailings storage facility is located on NFS lands and would be subject to Forest Service regulatory jurisdiction.

All power to the mine would be supplied by the Salt River Project. Portions of the proposed electrical infrastructure would be located on NFS land and would be subject to Forest Service regulatory jurisdiction. A Forest Service special use permit would be required to approve construction and operation of new power lines on NFS lands by the Salt River Project.

Access to the mine would be provided by existing roads. The Magma Mine Road would eventually be relocated as a result of expected subsidence.

Water for the process would come from a variety of sources. Filtrate from the filter plant, recycled water from the tailings storage facility, and recovered water from the concentrator complex would be recycled back into the mining process. Additional water would be obtained from dewatering of the mine workings, direct delivery of CAP water, and pumping from a well field along the MARRCO corridor.

Reclamation would be conducted to achieve post-closure land use objectives, including closing and sealing the mine shafts, removing surface facilities and infrastructure, and establishing self-sustaining vegetative communities using local species. The proposed tailings storage facility would be reclaimed in place, providing for permanent storage of mine tailings.

An initial review of the consistency of the proposed GPO with the forest plan indicates that approval of the proposed GPO would result in conditions that are inconsistent with the forest plan. An amendment to the forest plan would address the necessary changes to relevant standards and guidelines for managing visual quality and recreation opportunities as determined by the record of decision for the project.

ES-1.6.2 Land Exchange

Section 3003 of the NDAA directs the conveyance of specified Federal lands to Resolution Copper if Resolution Copper offers to convey the specified non-Federal land to the United States. The following summarizes the land parcels that would be exchanged.

- The United States would transfer the 2,422-acre **Oak Flat Federal Parcel** to Resolution Copper
- Resolution Copper would transfer the following parcels to the U.S. Department of Agriculture:

- 142 acres near Superior in Pinal County, Arizona, known as the **Apache Leap South End Parcel**, to be administered by the Tonto National Forest
- 148 acres in Yavapai County, Arizona, known as the **Tangle Creek Parcel**, to be administered by the Tonto National Forest
- 147 acres in Gila County, Arizona, known as the **Turkey Creek Parcel**, to be administered by the Tonto National Forest
- 149 acres near Cave Creek in Maricopa County, Arizona, known as the **Cave Creek Parcel**, to be administered by the Tonto National Forest
- 640 acres north of Payson in Coconino County, Arizona, known as the **East Clear Creek Parcel**, to be administered by the Coconino National Forest

- Resolution Copper would transfer the following parcels to the U.S. Department of the Interior:
  - Approximately 3,050 acres near Mammoth in Pinal County, Arizona, known as the **Lower San Pedro River Parcel**, to be administered by the BLM as part of the San Pedro Riparian National Conservation Area
  - Approximately 940 acres south of Elgin in Santa Cruz County, Arizona, known as the **Appleton Ranch Parcel**, to be administered by the BLM as part of the Las Cienegas National Conservation Area
  - 160 acres near Kearny in Gila and Pinal Counties, Arizona, known as the **Dripping Springs Parcel**, to be administered by the BLM
- An additional NDAA requirement calls for the United States to transfer the following land to Superior, Arizona, if the Town of Superior requests it:
  - 30 acres associated with the Fairview Cemetery
  - 250 acres associated with parcels contiguous to the Superior Airport
  - 265 acres of Federal reversionary interest associated with the Superior Airport

As of June 2019, the Town of Superior had not requested this land transfer.

ES-1.7 Nature of Lead Agency Decision

With regard to the proposed GPO, the Forest Supervisor, Tonto National Forest, would make the following decisions using the analysis in the EIS and supporting documentation:

- Decide whether to approve the proposed GPO submitted by Resolution Copper or require changes or additions to the proposed GPO to meet the requirements for environmental protection and reclamation set forth in 36 CFR 228 Subpart A before approving a final GPO. The Forest Service decision may be to authorize use of the surface of NFS lands in connection with mining operations under the GPO composed of elements from one or more of the alternatives considered.
- The alternative selected for approval in the final GPO must minimize adverse impacts on NFS surface resources to the extent feasible and must comply with all Federal and State laws and regulations
- Decide whether to approve amendments to the forest plan, which would be required to approve the final GPO
- Decide whether to approve a special use permit for the Salt River Project to authorize construction and operation of power lines on NFS lands

With regard to the land exchange, Section 3003 of the NDAA directs the Secretary of Agriculture to convey to Resolution Copper all right,

title, and interest of the United States in and to identified Federal land if Resolution Copper offers to convey to the United States all right, title, and interest of Resolution Copper in and to identified non-Federal lands.

The Forest Supervisor, Tonto National Forest, has limited discretion to (1) address concerns of affected Indian Tribes; (2) ensure that title to the non-Federal lands offered in the exchange is acceptable; (3) accept additional non-Federal land or a cash payment from Resolution Copper to the United States in the event that the final appraised value of the Federal land exceeds the value of the non-Federal land; or (4) address other matters related to the land exchange that are consistent with Section 3003 of the NDAA.

ES-1.8 Public Participation

The Forest Service sought public input during several phases of the environmental review process prior to publication of the DEIS.

The public scoping period began on March 18, 2016, with the Forest Service publication of a notice of intent to prepare an EIS in the Federal Register. Scoping is the first step in the NEPA process that seeks input from within the agency, from the public, and from other government agencies in order to define the scope of issues to be addressed in depth in the EIS.

The Forest Service planned for a 60-day public scoping period from March 18, 2016, to May 17, 2016.

Numerous individuals and several organizations requested an extension of the public scoping period, as well as additional public scoping meetings. The Forest Supervisor, Tonto National Forest, accommodated these requests by extending the public scoping period through July 18, 2016, resulting in a total overall scoping period of 120 days.

Between March and June 2016, the Forest Service held five EIS public scoping meetings.

A Scoping Report summarizing 133,396 public comments was completed and made available online on the project website on March 9, 2017.

The Forest Service conducted two public workshops to collect information on public opinion in regard to locating a mine tailings storage facility.

Internal scoping efforts included several meetings and field trips with the NEPA interdisciplinary (ID) team. ID team members include Forest Service resource specialists and planners representing anticipated topics of analysis in the NEPA process, managers, and Tonto National Forest line officers.

Cooperating agency scoping was conducted through a kick-off meeting and through comments submitted by cooperating agencies and tribes during the public scoping comment period.

Between May 2017 and May 2019, the Forest Service participated in numerous informal meetings (one or more per month) with key stakeholders, tribes, and cooperating agencies regarding technical feasibility of the project and alternatives, differing environmental impacts and tradeoffs among the alternatives, and mitigations for reducing expected impacts of the proposed mining plan of operations and land exchange.

Additional detail on scoping conducted during tribal consultation can be found in section 1.6.4 of the DEIS.

ES-1.9 Issues Selected for Analysis

Issues help set the scope of the actions, alternatives, and effects to consider in the Forest Service's analysis (Forest Service Handbook 1909.15.12.4).

Comments submitted during the 2016 scoping period were used to formulate issues concerning the proposed action. An issue is a point of dispute or disagreement with the proposed action based on some anticipated environmental effect.

Table ES-1 presents the social, physical, and biological resources or other concerns that the Forest Service selected for analysis, based on scoping comments.

Section 1.7, Issues, in chapter 1 of the DEIS provides a snapshot of these issues. Detailed information on these issues appears in chapter 3 of the DEIS.

Table ES-1. Issues carried forward for analysis

Social and Cultural Issues	Physical and Biological Issues
• Cultural Resources	• Air Quality
• Environmental Justice	• Geology, Minerals, and Subsidence
• Public Health and Safety	• Livestock and Grazing
• Recreation	• Noise and Vibration
• Socioeconomics	• Scenic Resources
• Transportation and Access	• Soils and Vegetation
• Tribal Values and Concerns	• Water Resources
	• Wildlife and Special Status Species

ES-2 ALTERNATIVES

NEPA requires consideration of a reasonable range of alternatives that can accomplish the purpose of and need for the proposed action. The Forest Service studied a range of alternatives to the Resolution Copper GPO, each of which

- responds to key issues raised during public scoping; project purpose and need; and applicable Federal and State laws and regulations;
- considers input from resource specialists, mining experts (project team), cooperating agency representatives, tribes, and stakeholders; and
- is technically feasible to implement—but with differing environmental impacts and tradeoffs.

The alternatives include five action alternatives (out of 30+ considered) at four separate locations, including one location not on Federal land.

In addition, the Forest Service did the following:

- Assessed alternative mining techniques in an effort to prevent subsidence. No alternative methods were considered reasonable.
- Assessed tailings disposal in brownfield sites (old mine pits). No reasonable brownfield locations were found.
- Identified three separate methods of depositing tailings, including using filtered (dry-stack) tailings.

Environmental impacts and tradeoffs among the five action alternatives vary due to the differences in the tailings embankment design; the tailings deposition method; or the geographic location and affected surroundings of the proposed tailings storage facility (figure ES-2). Ore extraction and processing activities as proposed in the GPO remain similar between all action alternatives.

Additional alternatives were considered but dismissed from detailed analysis for various reasons; see appendix F of the DEIS for discussion of the other alternatives considered and the rationale for their dismissal.

ES-2.1 No Action Alternative

This alternative is required by regulation (40 CFR 1502.14(d)). Under this alternative, the Forest Service would not approve the GPO, none of the activities in the final GPO would be implemented on NFS lands, and the mineral deposit would not be developed. Additionally, the land exchange would not take place.

However, the nature of the no action alternative for this project was described in the Notice of Intent issued in March 2016, which states:

> The EIS will analyze the no action alternative, which would neither approve the proposed GPO nor complete the land exchange. However, the responsible official—the Forest Supervisor, Tonto National Forest—does not have discretion to select the no action alternative, because it would not be consistent with the requirements of 36 CFR 228.5, nor would it comply with the NDAA.
>
> Additional alternatives may be evaluated in the EIS. These alternatives may require changes to the proposed GPO, which are necessary to meet Forest Service regulations for locatable minerals set forth at 36 CFR 228 Subpart A.

Thus, while this alternative cannot be selected by the Forest Service, it serves as a point of comparison for the proposed action and action alternatives.

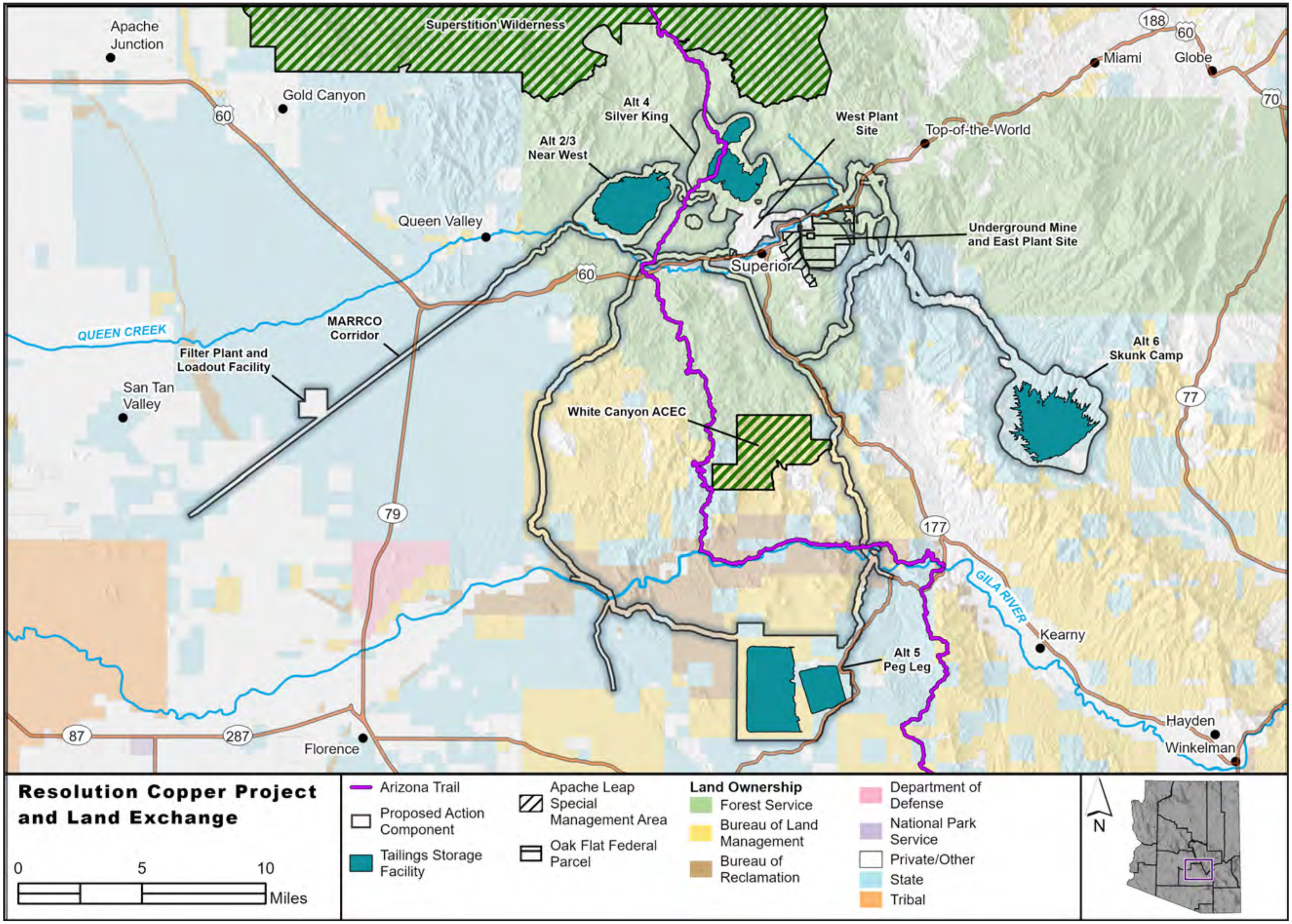

Figure ES-2. Overview of project alternative locations

ES-2.2 Alternative 2 – Near West Proposed Action

This alternative is a variation of the proposed action described in the May 9, 2016, version of the Resolution Copper GPO. In early 2018, Resolution Copper changed its original plan for an "upstream" embankment design to a "modified centerline" configuration for a tailings storage facility.

Alternative 2 would include a split-stream tailings processing method with two tailings types:

- Non-potentially acid generating (NPAG) tailings
- Potentially acid generating (PAG) tailings

PAG tailings have a greater potential to oxidize and generate acidic seepage to groundwater or surface waters. To minimize this potential, PAG tailings would be deposited centrally in the tailings storage facility and surrounded by NPAG tailings. A 5- to 10-foot-deep water cap would keep PAG tailings saturated to reduce exposure to oxygen during tailings storage facility development.

Additionally, the larger NPAG deposit would act as a buffer between the PAG tailings and areas outside the tailings storage facility. Water spigots would keep the NPAG tailings "beach" area wet, ensuring effective dust management during operations.

The modified centerline embankment construction would consist of earthfill and cyclone sand from the NPAG tailings stream. This sand results from tailings processed through one or more dedicated centrifuges to separate larger tailings particles from the finer particles.

n

A suite of engineered seepage controls, including engineered low-permeability liners, compacted fine tailings, and/or a "grouting" process to seal ground fractures, would limit and contain seepage. Uncontained seepage would be collected in downstream ponds and pumped back to the tailings storage facility. Figure ES-3 provides an overview of Alternative 2.

Alternative 2 Facility Details	
Ownership	Tonto National Forest
Tailings facility footprint	3,300 acres
Area excluded from public access during operations	4,900 acres
Embankment height	520 feet
Embankment length	10 miles
Tailings type	Slurry

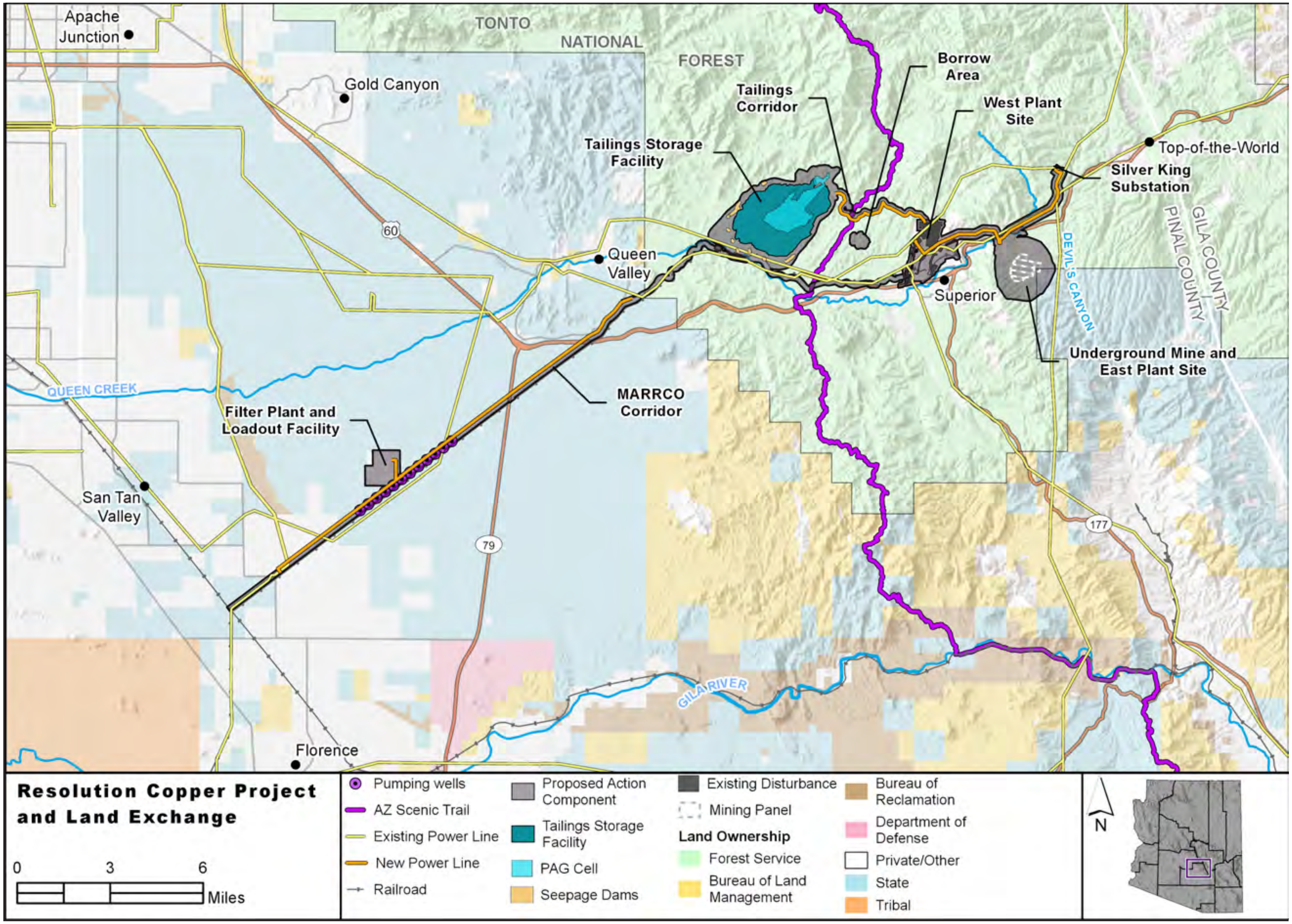

Figure ES-3. Alternative 2 – Near West Proposed Action

ES-2.3 Alternative 3 – Near West – Ultrathickened

ES-2.3.1 Similarities with Alternative 2

This alternative represents a variation of the proposed action described in the May 2016 GPO. It includes a change in embankment design for a tailings storage facility to a "modified centerline" configuration consisting of earthfill and cycloned sand.

Alternative 3 has a split-stream tailings processing method with two tailings types:

- NPAG tailings
- PAG tailings

A suite of engineered seepage controls, including engineered low-permeability liners, compacted fine tailings, and/or a "grouting" process to seal ground fractures, would limit and contain seepage, along with downstream seepage collection ponds.

The location on the Tonto National Forest would be identical. Figure ES-4 provides an overview of Alternative 3.

ES-2.3.2 Differences from Alternative 2

This alternative would use physical barriers to segregate PAG tailings in a separate cell from NPAG tailings. Cycloned sand would be used to build low-permeability "splitter berms" between the two tailings storage areas.

This alternative has a proposal to reduce initial amounts of water retained in NPAG tailings and encourage rapid evaporation, as well as reduce seepage potential, through

- additional on-site thickening of NPAG tailings, which would increase the thickness by 5 percent, reducing the overall amount of water in the facility; and
- possible use of "thin-lift" (also known as thin layer) deposition, to enhance evaporation and further reduce the amount of water in the facility.

Alternative 3 would require less time to close the recycled water pond, compared with Alternative 2. By using ultrathickening methods that reduce water entering the tailings, officials estimate closure in 5 years, compared with 25 years estimated for Alternative 2.

Alternative 3 Facility Details

Ownership	Tonto National Forest
Tailings facility footprint	3,300 acres
Area excluded from public access during operations	4,900 acres
Embankment height	510 feet
Embankment length	10 miles
Tailings type	Thickened slurry

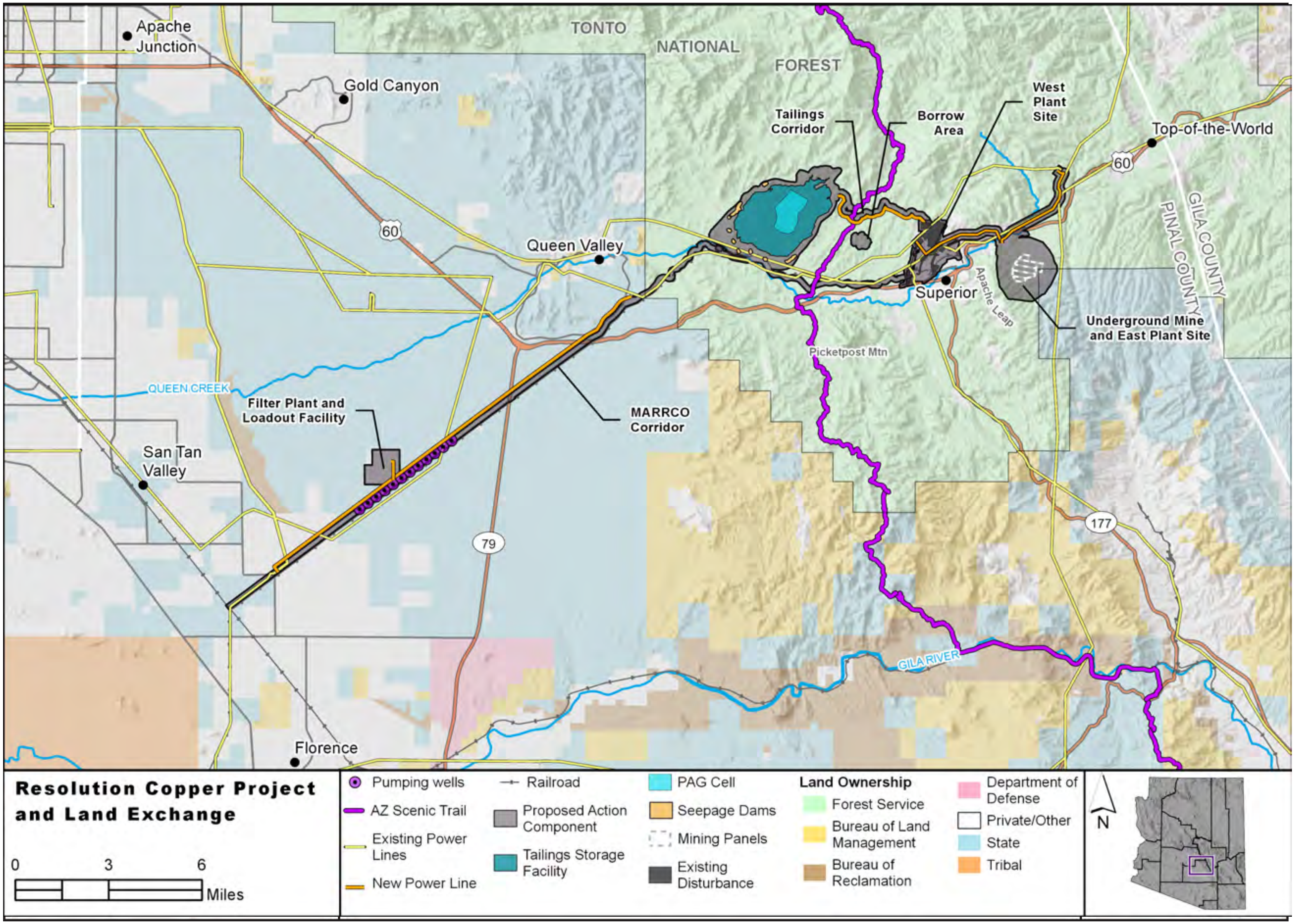

Figure ES-4. Alternative 3 – Near West – Ultrathickened

ES-2.4 Alternative 4 – Silver King

This is the lone alternative proposing to use filtered tailings—instead of slurry tailings—at the tailings storage facility.

As with other alternatives, Alternative 4 would include a split-stream tailings processing method with two tailings types:

- NPAG tailings
- PAG tailings

From the West Plant Site, pipelines would transport the two tailings slurry streams to filter plants at the Silver King location north of the West Plant Site and the town of Superior. Pressure filters would extract about 85 percent of the water from the tailings, resulting in a more solid product and a decrease in water pumped for operations. The water would be recycled in the process water at the West Plant Site.

Conveyors and mobile equipment would mechanically deposit NPAG and PAG tailings in two separate, adjacent tailings storage facilities. Figure ES-5 provides an overview of Alternative 4.

To limit exposure of tailings to water, all runoff would be directed to perimeter ditches, sumps, and/or underdrains. Water coming into contact with exposed tailings would be collected in large ponds located in natural valleys downstream of the tailings storage facility. Large diversions also would be needed to keep upstream stormwater from reaching the tailings storage facility.

ES-2.4.1 Arizona National Scenic Trail

The tailings storage facility and associated auxiliary facilities would impact approximately 5.5 miles of the Arizona National Scenic Trail (Arizona Trail), resulting in the rerouting of that portion of the trail.

Alternative 4 Facility Details

Ownership	Tonto National Forest
Tailings facility footprint	2,300 acres
Area excluded from public access during operations	5,700 acres
Embankment height	Filtered tailings do not use an embankment to contain tailings; however, for comparison with the other alternatives, the overall height of the facility would be approximately 1,000 feet.
Embankment length	Not applicable
Tailings type	Filtered

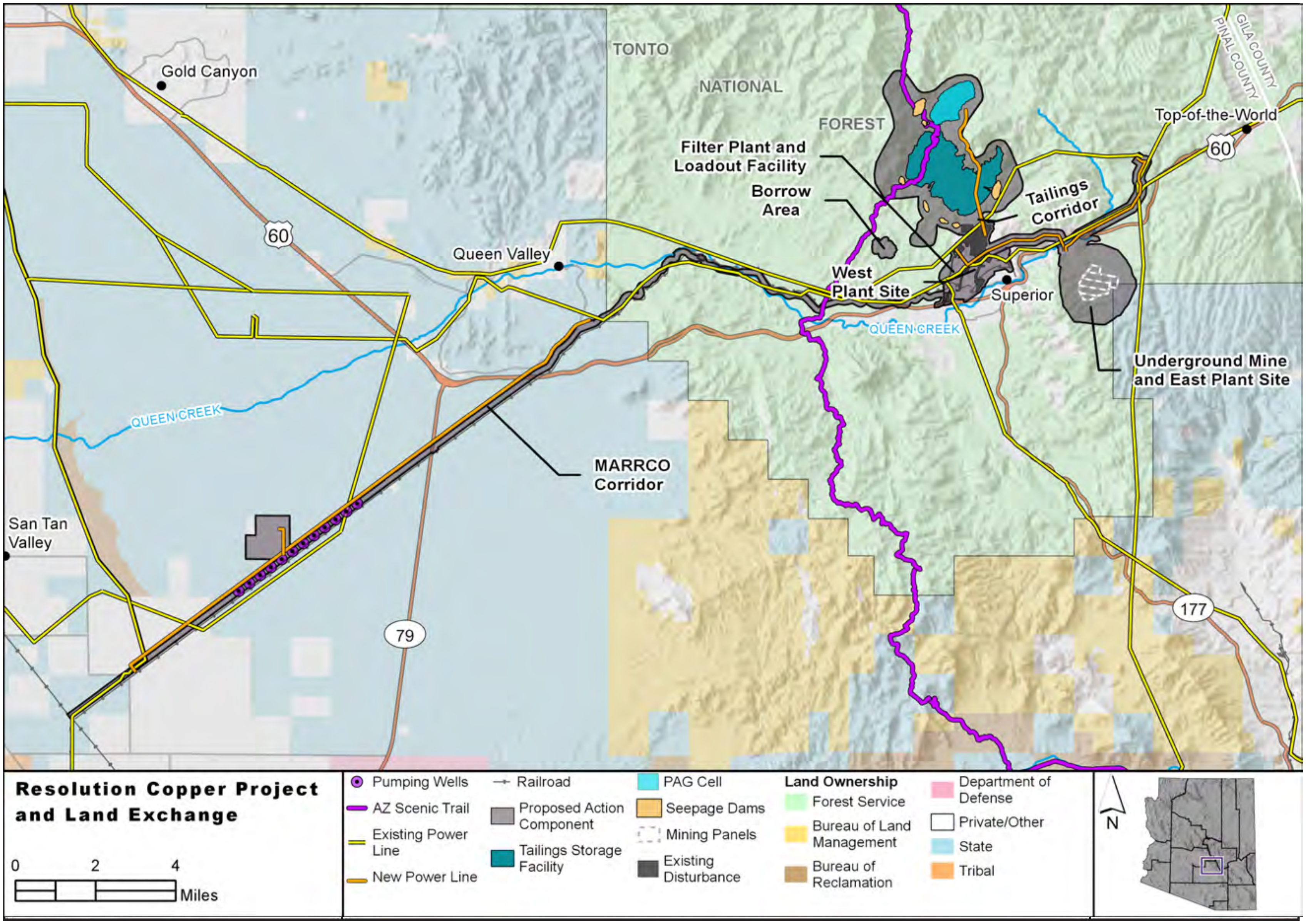

Figure ES-5. Alternative 4 – Silver King

ES-2.5 Alternative 5 – Peg Leg

This alternative allows an evaluation of a tailings site that is more isolated from existing communities while remaining adjacent to areas of active mining on the landscape.

Alternative 5 also provides for a comparison of the impacts of slurry tailings if placed on a flatter, alluvial setting instead of an upland wash or canyon.

As with other alternatives, Alternative 5 would include a split-stream tailings processing method with two tailings types:

- NPAG tailings
- PAG tailings

Two options are analyzed for tailings conveyance from the West Plant Site. Only one option would be selected for use to transport the tailings slurry streams to the Peg Leg tailings storage facility. The west option is approximately 28 miles long, whereas the east option is approximately 23 miles long.

Two separate storage facilities for NPAG and PAG tailings would exist throughout the life of the mine.

The PAG facility would consist of four separate cells. This would reduce the pond size required for operations and allow for progressive reclamation. Only one cell would be operational at a time. A downstream embankment consisting of earthfill and cycloned sand is proposed for the PAG cells.

NPAG tailings would be located primarily on an alluvial soil foundation to the west and slightly downslope from the PAG site. A centerline embankment, also consisting of earthfill and cycloned sand, is proposed for NPAG tailings. Figure ES-6 provides an overview of Alternative 5.

Officials project higher seepage because of the alluvial foundation. A suite of engineered seepage controls, including low-permeability layers at the PAG facility and low-permeability barriers (liners or fine-grained tailings) for the NPAG tailings, would limit and control seepage. A downstream well field would capture seepage and return it to the tailings storage facility.

Alternative 5 Facility Details

Ownership	Bureau of Land Management; Arizona State Land Department
Tailings facility footprint	5,900 acres
Area excluded from public access during operations	10,800 acres
Embankment height	310 feet
Embankment length	7 miles
Tailings type	Slurry

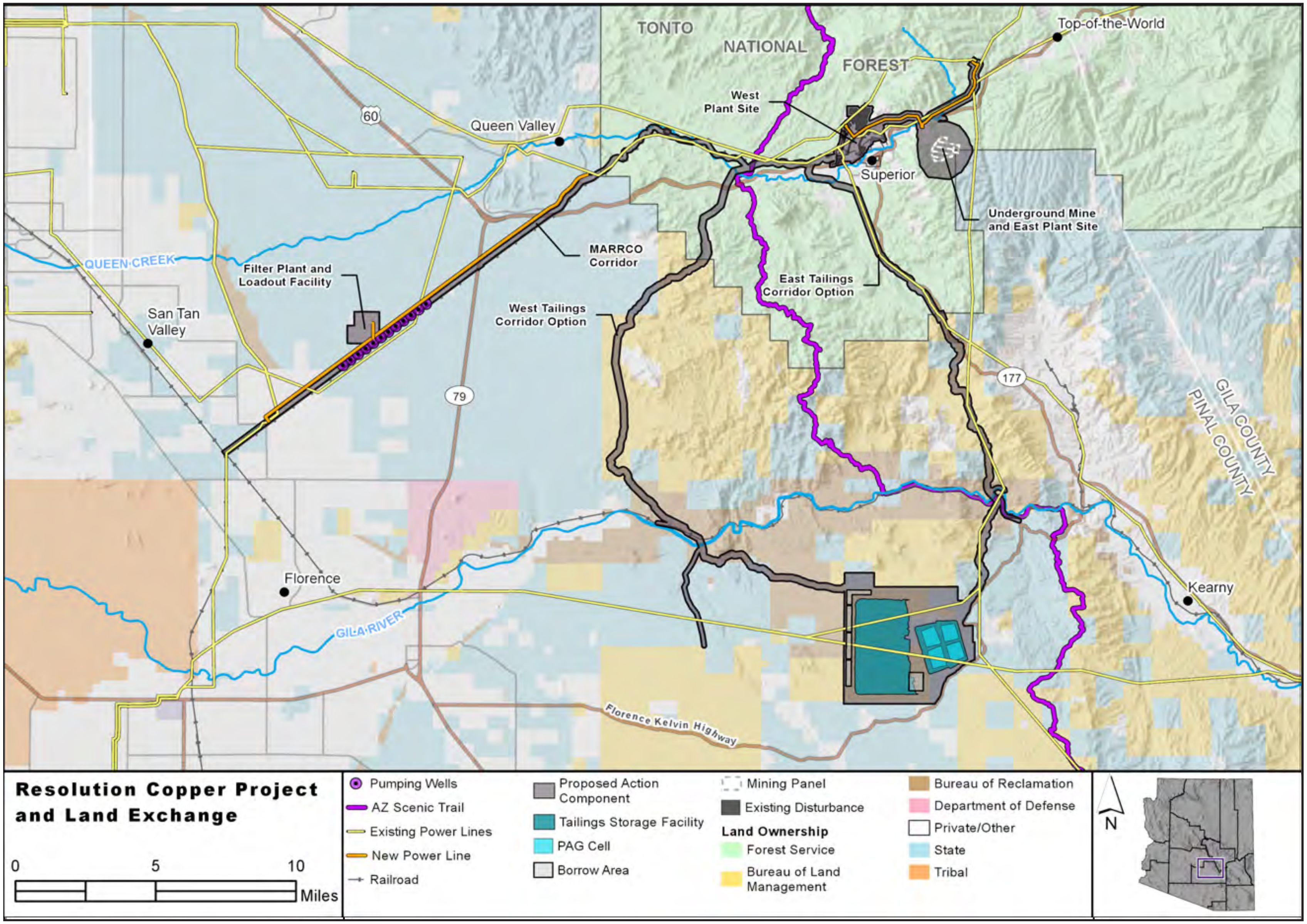

Figure ES-6. Alternative 5 – Peg Leg

ES-2.6 Alternative 6 – Skunk Camp

Preferred Alternative

The Forest Service has identified Alternative 6 (Skunk Camp) – North Option as the Lead Agency's preferred alternative and seeks public feedback during the 90-day comment period regarding this choice.

Alternative 6 Facility Details

Ownership	Private land; Arizona State Land Department
Tailings facility footprint	4,000 acres
Area excluded from public access during operations	8,600 acres
Embankment height	490 feet
Embankment length	3 miles
Tailings type	Slurry

The north option for tailings conveyance is the preferred route in the DEIS. Development of this alternative centered on three components:

- Its location is largely isolated from human residences and other infrastructure.
- It is adjacent to an existing mine (Ray Mine).
- Its location enables use of cross-valley embankments, requiring less fill to retain tailings, compared with a ring-like impoundment. This, in turn, simplifies construction and operations.

As with other alternatives, Alternative 6 would include a split-stream tailings processing method with two tailings types:

- NPAG tailings
- PAG tailings

Two options are analyzed for tailings conveyance from the West Plant Site. Only one option would be selected for use to transport the tailings slurry streams to the Skunk Camp tailings storage facility. The north option is approximately 20 miles long, whereas the south option is approximately 25 miles long.

NPAG tailings would be cycloned to produce embankment fill with cycloned overflow—the finer particles—thickened at the tailings storage facility before discharge into the impoundment. PAG tailings would be deposited in two separate cells, behind a separate cycloned sand downstream-type embankment, to the north (upstream) end of the facility. Only one cell would be operational at a time, providing for early reclamation of the first cell. The much larger volume of NPAG tailings would be behind its own embankment of compacted cycloned sand and deposited immediately south of (downstream) and adjacent to the PAG tailings.

A suite of engineered seepage controls, including engineered low-permeability liners, compacted fine tailings, and/or a "grouting" process to seal ground fractures, would provide a low-permeability layer to limit and control seepage. A seepage collection pond also would be placed downstream. Figure ES-7 provides an overview of Alternative 6.

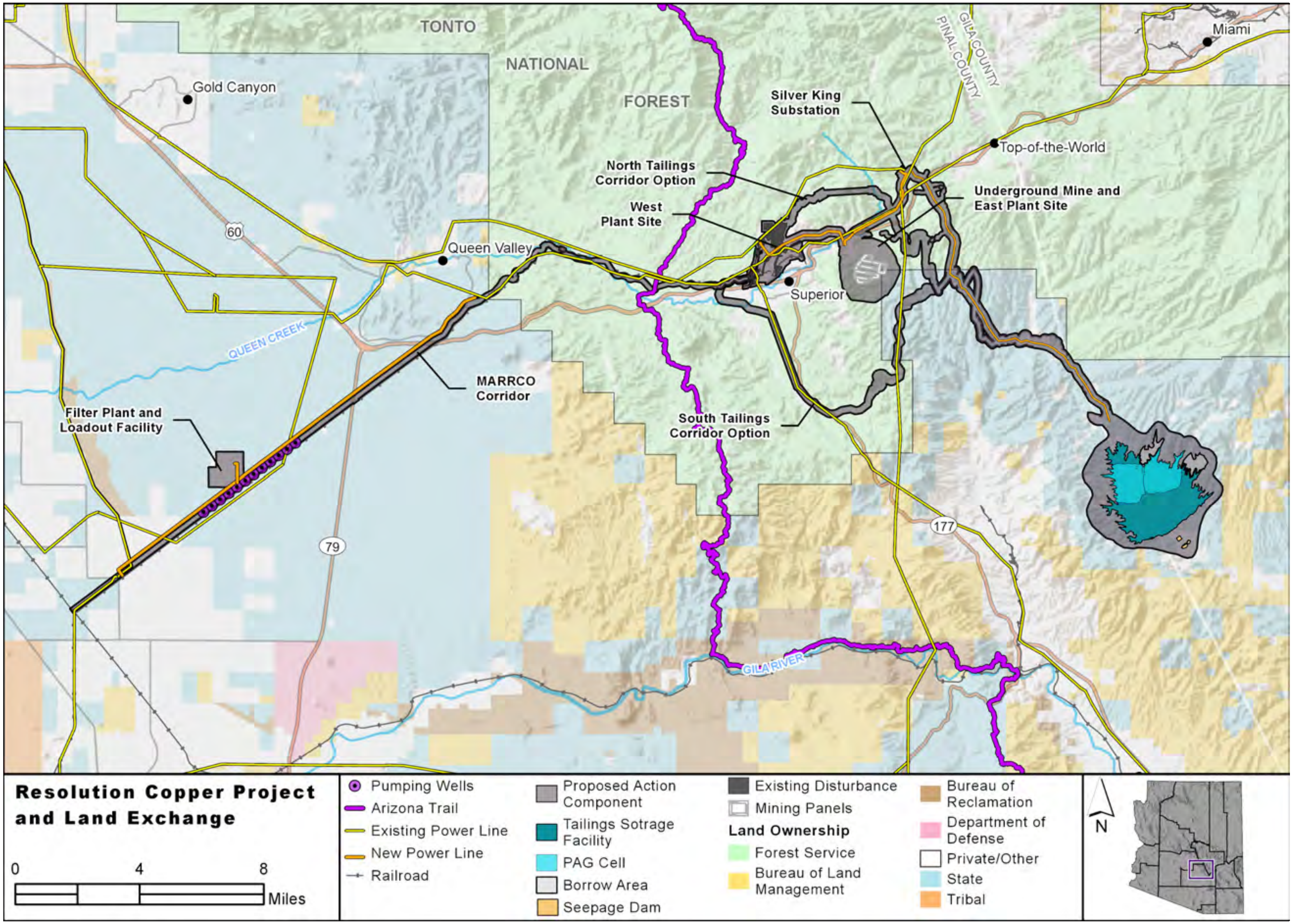

Figure ES-7. Alternative 6 – Skunk Camp (preferred alternative)

ES-3 SUMMARY OF IMPACTS

ES-3.1 Introduction

Information in chapter 3 of the DEIS describes the natural and human environment that may be affected by the proposed action and its alternatives and discloses the direct, indirect, and cumulative impacts that could occur as a result of implementation of the proposed action or alternatives. The effects of the legislated land exchange are also disclosed in the DEIS. Forest Service management regulations would no longer apply on 2,422 acres of the Oak Flat Federal Parcel transferred to Resolution Copper. Approximately 5,376 acres would transfer from private ownership to Federal ownership and regulations.

ES-3.2 Geology, Minerals, and Subsidence

This section describes known geological characteristics at each of the major facilities of the proposed mine—including alternative tailings storage locations—and how the development of the project may impact existing cave and karst features, paleontological resources, area seismicity, and unpatented mining claims. It also outlines subsidence impacts that would result from Resolution Copper's plans to extract the ore from below the deposit using a mining technique known as "block caving" or "panel caving." The analysis concludes the following:

- The subsidence crater at the Oak Flat Federal Parcel would break through at mine year 6, would be between 800 and 1,115 feet deep, and would be about 1.8 miles in diameter.
- No damage is expected to Apache Leap, Devil's Canyon, or U.S. Route 60 because of the subsidence. The mine is also unlikely to induce seismic activity that would cause damage.
- Some unpatented mining claims not belonging to Resolution Copper are located within the project footprint, and access to these claims may be inhibited.

ES-3.3 Soils and Vegetation

This section explains how the proposed mine would disturb large areas of ground and potentially destroy native vegetation, including species given special status by the Forest Service, and encourage noxious or invasive weeds. The analysis concludes the following:

- Between 10,000 and 17,500 acres of soil and vegetation would be disturbed by the project.
- Revegetation success in these desert ecosystems is demonstrated. However, impacts to soil health and productivity may last centuries to millennia, and the ecosystem may not meet desired future conditions. The habitat may be suitable for generalist wildlife and plant species, but rare plants and wildlife with specific habitat requirements are unlikely to return.
- Arizona hedgehog cactus (endangered) may be impacted during operations at the East Plant Site and by ground subsidence. The pipeline corridors associated with Alternative 5 would impact critical habitat for acuña cactus (endangered).
- Reclamation of disturbed areas would decrease but not eliminate the likelihood of noxious weeds becoming established or spreading.

ES-3.4 Noise and Vibration

This section provides a detailed analysis of estimated impacts from noise and vibration under the GPO-proposed mine plan and each of the alternatives. The analysis concludes the following:

- Noise impacts were modeled for 15 sensitive receptors representing residential, recreation, and conservation land uses. Under most conditions, predicted noise and vibration during construction and operations, for both blasting and non-blasting activities, at sensitive receptors are below thresholds of concern; rural character would not change due to noise.

- One exception is that noise along Dripping Springs Road (Alternative 6) is above thresholds of concern; however, mitigation to change the access road would remedy this. After mitigation, no unavoidable adverse impacts are anticipated from noise or vibration from any alternative.

ES-3.5 Transportation and Access

This section discusses how the proposed Resolution Copper Mine would increase traffic on local roads and highways and likely alter local and regional traffic patterns and levels of service. This section also examines NFS road closures, along with accelerated deterioration of local roadways as a result of increased use. The analysis concludes the following:

- Approximately 6.9 miles of NFS roads are expected to be decommissioned or lost from the East Plant Site, West Plant Site, or subsidence area.
- An additional 21.7 miles of NFS roads would be lost as a result of the Alternative 2 and 3 tailings storage facility, and 17.7 miles of NFS roads would be lost as a result of the Alternative 4 tailings storage facility. Approximately 29 miles of BLM inventoried roads would be lost as a result of the Alternative 5 tailings storage facility. The Alternative 6 tailings storage facility would impact only about 7 miles of private roads.
- NFS roads lost to the subsidence area provide access to areas that include Apache Leap and Devil's Canyon; access would still be available to these areas but would require using routes that are not as direct or convenient. Alternative 4 would also change access to the highlands north of Superior, as well as to private inholdings in the Tonto National Forest.

ES-3.6 Air Quality

This section analyzes potential impacts from an increase in dust, wind-borne particulates, and transportation-related emissions as a result of construction, mining, and reclamation activities at the mine and along transportation and utility corridors. The analysis concludes the following:

- Neither daily nor annual maximum impacts for fugitive dust (PM2.5 and PM10) would exceed established air quality thresholds.
- None of the predicted results are anticipated to exceed the National Ambient Air Quality Standards (NAAQS) at the project fence line (where public access is excluded).
- Impacts on air quality-related values (deposition and visibility) at Class 1 and other sensitive areas would be within acceptable levels.

ES-3.7 Water Resources

This section analyzes how the Resolution Copper Project could affect water availability and quality in three key areas: groundwater quantity and groundwater-dependent ecosystems (GDEs); groundwater and surface water quality; and surface water quantity. The analysis concludes the following:

- Between 14 and 16 GDEs are anticipated to be impacted: six of these are springs that are anticipated to be impacted by groundwater drawdown under the no action alternative as a result of ongoing dewatering by Resolution Copper; when block-caving occurs, groundwater impacts expand to overlying aquifers, and two more springs are impacted; direct disturbance within the project footprint would impact another two to five springs; and, depending on the alternative, GDEs associated with Queen Creek, Devil's Canyon, and the Gila River would

be impacted as a result of reductions in surface runoff. The loss of water would be mitigated for some GDEs, but impacts to the natural setting would remain.

- Groundwater supplies in Superior and Top-of-the-World could be impacted by groundwater drawdown but would be replaced through mitigation.
- Over the mine life, 87,000 acre-feet of water would be pumped from the mine, and between 180,000 and 590,000 acre-feet of makeup water would be pumped from the Desert Wellfield in the East Salt River valley. Alternative 4, which uses filtered (dry-stack) tailings, requires the least amount of makeup water. The wellfield pumping would incrementally contribute to the lowering of groundwater levels and cumulatively reduce overall groundwater availability in the area.
- After closure, the reflooded block-cave zone could have poor water quality; however, a lake in the subsidence crater is not anticipated, and no other exposure pathways exist for this water.
- Stormwater runoff could have poor water quality, but no stormwater contacting tailings or facilities would be released during operations or post-closure until reclamation is successful.
- All of the tailings facilities would lose seepage with poor water quality to the environment, and all are dependent on a suite of engineered seepage controls to reduce this lost seepage. Modeling indicates that seepage from Alternatives 2 and 4 would result in water quality problems in Queen Creek; Alternative 3 would not, but requires highly efficient seepage control to achieve this (99.5 percent capture). Seepage from Alternatives 5 and 6 does not result in any anticipated water quality problems; these alternatives also have substantial opportunity for additional seepage controls if needed.
- There would be a reduction in average annual runoff as a result of the capturing of precipitation by the subsidence crater and tailings facilities, varying by alternative: 3.5 percent at the mouth of Devil's Canyon, between 6.5 and 8.9 percent in Queen Creek at Whitlow Ranch Dam, and between 0.2 and 0.5 percent in the Gila River. Alternative 4 also would result in an almost 20 percent loss of flow in Queen Creek at Boyce Thompson Arboretum.
- Under the Clean Water Act, Alternatives 2, 3, and 4 impact zero acres of jurisdictional waters, based on a decision by the USACE that no such waters exist above Whitlow Ranch Dam. Alternative 5 impacts about 180 acres, and Alternative 6 impacts about 120 acres of potentially jurisdictional waters.

ES-3.8 Wildlife and Special Status Wildlife Species

This section describes how impacts to wildlife can occur from habitat loss and fragmentation, as well as from artificial lighting, noise, vibration, traffic, loss of water sources, or changes in air or water quality. The analysis concludes the following:

- Habitat would be impacted in the analysis area for 50 special status wildlife species. General impacts include a high probability of mortality or injury with vehicles or from grading, increased stress due to noise, vibration, and artificial light, and changes in cover. Changes in behavior include changes in foraging efficiency and success, changes in reproductive success, changes in growth rates of young, changes in predator–prey relationships, increased movement, and increased roadkill.
- There would be loss and fragmentation of movement and dispersal habitats from the subsidence area and tailings storage facility. Ground-clearing and consequent fragmentation of habitat blocks for other mine-related facilities would also inhibit wildlife movement and increase edge effects.
- For Tonto National Forest and BLM sensitive wildlife species, the proposed project may adversely impact individuals but is not likely to result in a loss of viability in the analysis area,

nor is it likely to cause a trend toward Federal listing of these species as threatened or endangered.

- Western yellow-billed cuckoo (endangered) could be impacted by general removal of vegetation and increased activity. The potential changes in stream flow and associated riparian vegetation along Devil's Canyon are specific concerns.
- Southwestern willow flycatcher (endangered) could be impacted by pipeline crossings of the Gila River under Alternative 5, including removal of vegetation and increased activity.
- Critical habitat for Gila chub occurs in Mineral Creek above Devil's Canyon. However, no individuals have been identified here during surveys, and this area is not expected to be impacted by groundwater drawdown.

ES-3.9 Recreation

This section quantifies, when possible, anticipated changes to some of the area's natural features and recreational opportunities as a result of infrastructure development related to the project. The analysis concludes the following:

- Public access would be eliminated permanently on 4,900 to 10,800 acres. Alternatives 2, 3, and 4 would result in 4,900 to 5,700 acres of access lost on Tonto National Forest land. Alternative 5 would primarily impact access to 10,800 acres of BLM land, and Alternative 6 would primarily impact access to 10,100 acres, of which 7,700 is Arizona State land.
- There would be changes to the recreation opportunity spectrum acres within the Globe Ranger District, ranging from 13 to 17 percent of semi-primitive non-motorized, 16 to 17 percent of semi-primitive motorized, and 5 to 7 percent of roaded natural.
- Visitors to the Superstition Wilderness, Picketpost Mountain, and Apache Leap would have foreground and background views of the tailings facilities from trails and overlooks, and the recreation setting from certain site-specific views could change. Three miles of the Arizona Trail would be impacted by Alternative 4 and require rerouting, whereas pipeline corridor crossings for Alternatives 2 and 5 would impact the trail.
- The exchange of the Oak Flat Federal Parcel would remove world-recognized rock climbing areas from public access, as well as Oak Flat Campground. Both of these would be partially mitigated by replacement areas.
- The number of Arizona hunting permits that are issued in individual Game Management Units would not change as a result of implementation of any of the action alternatives.

ES-3.10 Public Health and Safety

This section addresses three areas of interest: tailings embankment safety, fire risks, and the potential for releases or public exposure to hazardous materials. The analysis concludes the following:

- The risk of embankment failure for all alternatives would be minimized by required adherence to Federal and Arizona design standards and by applicant-committed environmental protection measures.
- The consequences of a catastrophic failure and the downstream flow of tailings would include possible loss of life and limb, destruction of property, displacement of large downstream populations, disruption of the Arizona economy, contamination of soils and water, and risk to water supplies and key water

infrastructure like the CAP canal. The highest population is downstream of Alternative 2.

- All alternative designs are built to the same safety standards, but they have inherent differences in their resilience when unexpected events or upsets happen. Alternatives 2 and 3 are the least resilient because they use modified-centerline embankments, have long (10-mile) freestanding embankments, and do not use separately contained PAG storage cells. Alternative 6 is the most resilient, using a centerline embankment that is only 3 miles long and anchored on each side, with separate PAG storage cells using downstream embankments.
- Alternative 4, using filtered (dry-stack) tailings, would have the fewest consequences if a failure occurred, collapsing as a slump or landslide, and impacting the local vicinity only.
- With respect to other public safety risks, the risk of inadvertent ignition and resulting wildland fire is considered quite low. However, Alternative 4 includes areas classified with shrub fuels that burn with high intensity in the event of an ignition. As Mine Safety and Health Administration and other regulations and standards govern the transport and storage of explosives and hazardous chemicals, risks of spills or releases are therefore considered possible, but unlikely, with appropriate response plans in place.

ES-3.11 Scenic Resources

This section addresses the existing conditions of scenic resources (including dark skies) in the area of the proposed action and alternatives. It also addresses the potential changes to those conditions from construction and operation of the proposed project. The analysis concludes the following:

- All tailings facilities would be visible from long distances, and the change in contrast caused by land disturbance and vegetation removal, dust, and equipment would strongly impact viewers, including recreationists on scenic highways.
- Alternatives 2 and 3 would impact Arizona Trail users and off-highway vehicle users, as would Alternative 4. Alternative 4 would be the tallest facility when viewed (1,000 feet in height); it would dominate the scene and be viewable from sensitive locations (like Picketpost Mountain). Alternative 5 would also be highly visible and would impact Arizona Trail and off-highway vehicle users. Alternative 6 would be visible from within the valley of Dripping Spring Wash but otherwise would not be as visible on the landscape as the other alternatives.

ES-3.12 Cultural Resources

This section analyzes potential impacts on all known cultural resources within the project area. The analysis concludes the following:

- The NRHP-listed *Chí'chil Biłdagoteel* Historic District TCP would be directly and permanently damaged by the subsidence area at the Oak Flat Federal Parcel.
- All alternative areas would have 100 percent pedestrian surveys; the majority of surveys have been completed. From surveyed areas, the number of NRHP-eligible sites are as follows: Alternatives 2 and 3 (101 sites); Alternative 4 (122 sites); Alternative 5 (114–125 sites, depending on pipeline route); and Alternative 6 (318–343 sites, depending on pipeline route).
- Additional sites would be directly impacted but have undetermined eligibility, would be indirectly impacted, or are within a 6-mile buffer area and would be impacted by the change in the landscape as a result of the proposed mine.

ES-3.13 Socioeconomics

This section examines the social and economic impacts on the quality of life for neighboring communities near the proposed mine. The analysis concludes the following:

- On average, the mine is projected to directly employ 1,500 workers, pay about $134 million per year in total employee compensation, and purchase about $546 million per year in goods and services. Including direct and multiplier effects, the proposed mine is projected to increase average annual economic value added in Arizona by about $1 billion.
- The proposed mine is projected to generate an average of between $88 and $113 million per year in State and local tax revenues and would also produce substantial revenues for the Federal Government, estimated at more than $200 million per year. There would be a loss of hunting revenue as a result of the tailings storage facilities; the loss would be highest in the Superior area with Alternatives 2, 3, and 4.
- Construction and operations of the proposed mine could affect costs for both the Town of Superior and Pinal County to maintain street and road networks. A number of agreements between Resolution Copper and the Town of Superior would offset impacts to quality of life, education, and emergency services.
- Property values are expected to decline in close proximity to the tailings storage facilities.

ES-3.14 Tribal Values and Concerns

This section discusses the high potential for the proposed mine to directly, adversely, and permanently affect numerous cultural artifacts, sacred seeps and springs, traditional ceremonial areas, resource gathering localities, burial locations, and other places and experiences of high spiritual and other value to tribal members.

- Development of the Resolution Copper Mine would directly and permanently damage the NRHP-listed *Chí’chil Biłdagoteel* Historic District TCP. One or more Emory oak groves at Oak Flat, used by tribal members for acorn collecting, would likely be lost. Other unspecified mineral or plant collecting locations and culturally important landscapes are also likely to be affected.
- Between 14 and 16 GDEs, mostly sacred springs, would be anticipated to be impacted by dewatering. Although mitigation would replace water, impacts would remain to the natural setting of these places.
- Burials are likely to be impacted; the numbers and locations of burials would not be known until such sites are detected as a result of project-related activities.

ES-3.15 Environmental Justice

This section examines issues in the context of the Resolution Copper Project and Land Exchange that have the potential to harm vulnerable or disadvantaged communities. The analysis concludes the following:

- There are five environmental justice communities in the area, as well as Native American communities, that would be impacted by cultural impacts described above. Economic effects from the mine would be most apparent in the town of Superior (an environmental justice community). Housing shortages, pressure on municipal services and schools, and price increases would potentially adversely affect low-income and minority individuals.

ES-3.16 Livestock and Grazing

This section discloses the impacts to currently authorized livestock grazing on lands managed by the Forest Service, BLM, or Arizona State

Land Department that are located within the project area. The analysis concludes the following:

- There would be a reduction in available allotment acreage (BLM, Forest Service, and Arizona State land) ranging from 7,500 to 16,000 acres and a proportional reduction in livestock capacity from 1,300 to 5,300 animal-unit months. The water sources and grazing infrastructure associated with these allotment areas would also be lost.

ES-3.17 Impact Avoidance, Minimization, and Mitigation

The DEIS serves in part to inform the public and review agencies of design features, best management practices, and mitigation measures that are included with the project to reduce or avoid impacts. The Forest Service views these elements as part of the project and considers Resolution Copper's proposed mitigation measures, described in appendix J of the DEIS, as inherent to the proposed alternative, as well as other action alternatives' applicable components.

To the extent possible, these measures, including any potential impacts associated with these measures, were considered when assessing the impacts of the project on the resources. Where there is insufficient detail to determine whether an impact can be avoided or minimized, the measure cannot be incorporated into the impact analysis but serves to inform the public of Resolution Copper's plans.

Additional mitigation measures identified or recommended to date during the NEPA process have been compiled and would be considered by the Forest Service and cooperating agencies as part of their permit decisions to further minimize project impacts. This list will be updated after public review of the DEIS for a comprehensive list of all measures identified during the NEPA process.

All measures will be assessed with the goal of disclosing the likelihood that the measures would be adopted by the applicant or implemented as a condition in a State, Federal, or local permit by the responsible agencies as part of their permit decisions following completion of the NEPA process. Specific mitigation conditions would be determined following completion of the environmental review and would be included in the record of decision for any permit that may be issued.

Compensatory mitigation for unavoidable impacts to aquatic resources may be required to ensure that activities requiring a permit comply with 404(b)(1) guidelines. Compensatory mitigation is the restoration (reestablishment or rehabilitation), establishment (creation), enhancement, and/or in certain circumstances preservation of aquatic resources to offset unavoidable adverse impacts.

Resolution Copper has developed a draft Conceptual Compensatory Mitigation Plan outlining its proposed approach for compensatory mitigation. The draft Conceptual Compensatory Mitigation Plan would be amended in the future to include proposed mitigation plans. In addition, Resolution Copper proposes to use monitoring measures through construction, operation, and closure of the project to assess predicted project impacts and the effectiveness of mitigation measures.

The draft Conceptual Compensatory Mitigation Plan submitted to the USACE by Resolution Copper is included in the EIS as appendix D.

ES-4 DEIS APPENDICES

The final section of the DEIS provides detailed information on 15 subjects. These appendices are as follows:

- Appendix A: Section 3003 of the NDAA
- Appendix B: Existing Conditions of Offered Lands
- Appendix C: Draft Practicability Analysis in Support of Clean Water Act 404(B)(1) Alternatives Analysis
- Appendix D: Draft Resolution Copper Project Clean Water Act Section 404 Conceptual Compensatory Mitigation Plan
- Appendix E: Alternatives Impact Summary

- Appendix F: Alternatives Considered but Dismissed from Detailed Analysis
- Appendix G: Further Details of East Plant Site, West Plant Site, MARRCO Corridor, and Filter Plant and Loadout Facility Infrastructure
- Appendix H: Further Details of Mine Water Balance and Use
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- Appendix M: Water Quality Modeling Results for Constituents of Concern
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- Appendix O: Draft Programmatic Agreement Regarding Compliance with the NHPA on the Resolution Copper Project and Southeast Arizona Land Exchange

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CHAPTER 1

Overview

On March 18, 2016, the Tonto National Forest issued a Notice of Intent to prepare an environmental impact statement for the Resolution Copper Project and Land Exchange.

Three separate but related components would be analyzed in the EIS:

- Approval of a proposed mine plan governing surface disturbance on NFS lands outside of the exchange parcels from mining operations that are reasonably incident to extraction, transportation, and processing of copper and molybdenum that was submitted to the Tonto National Forest in November 2013
- Approval of an amendment to the Tonto National Forest Plan, if needed.
- Resolution Copper increased the offered parcel by an additional 32 acres of privately held land that is adjacent to the 110 acres presented in the NDAA as part of the Apache Leap Special Management Area. The additional land was provided to allow for a more contiguous parcel and for ease of surveying.

Purpose of and Need for Action

1.1 Introduction

The U.S. Forest Service (Forest Service) is a land management agency under the U.S. Department of Agriculture. The Forest Service's mission is to sustain the health, diversity, and productivity of the Nation's forests and grasslands to meet the needs of present and future generations. The Tonto National Forest, a unit of the Forest Service located in south-central Arizona, prepared this environmental impact statement (EIS) to disclose the potential environmental effects of the Resolution Copper Project and Land Exchange (project). The project includes (1) the Southeast Arizona Land Exchange (land exchange), a congressionally mandated exchange of land between Resolution Copper Mining, LLC (Resolution Copper) and the United States; (2) approval of the "General Plan of Operations" (GPO)[1] for any operations on National Forest System (NFS) land associated with a proposed large-scale underground mine (Resolution Copper Project); and (3) amendments to the "Tonto National Forest Land and Resource Management Plan" (forest plan) (1985, as amended).

Resolution Copper is a limited liability company that is owned by Rio Tinto (55 percent) and

Historical Magma Mine workings and the smelter complex

BHP (45 percent). Rio Tinto is the managing member. In November 2013, Resolution Copper submitted a proposed GPO to the Forest Service for development and operation of a large-scale mine near Superior, Arizona (figure 1.1-1).[2] The proposed GPO sought authorization for surface disturbance on NFS lands for mining operations and processing of copper and molybdenum. The proposed mine would be located in the Globe and Mesa Ranger Districts.The Forest Service determined the proposed GPO to be complete in December 2014 (U.S. Forest Service 2014c). As

1. The GPO, as amended, is available online at and at the Tonto National Forest Supervisor's Office, 2324 East McDowell Road, Phoenix, AZ 85006.
2. The maps contained in this EIS are based on a variety of sources of electronic and geographic data. Every effort has been made to ensure the correctness of these data coverages; however, the U.S. Department of Agriculture Forest Service makes no warranty, expressed or implied, about the accuracy, reliability, completeness, or utility of geospatial data not developed specifically for the Resolution Copper Project and Land Exchange EIS.

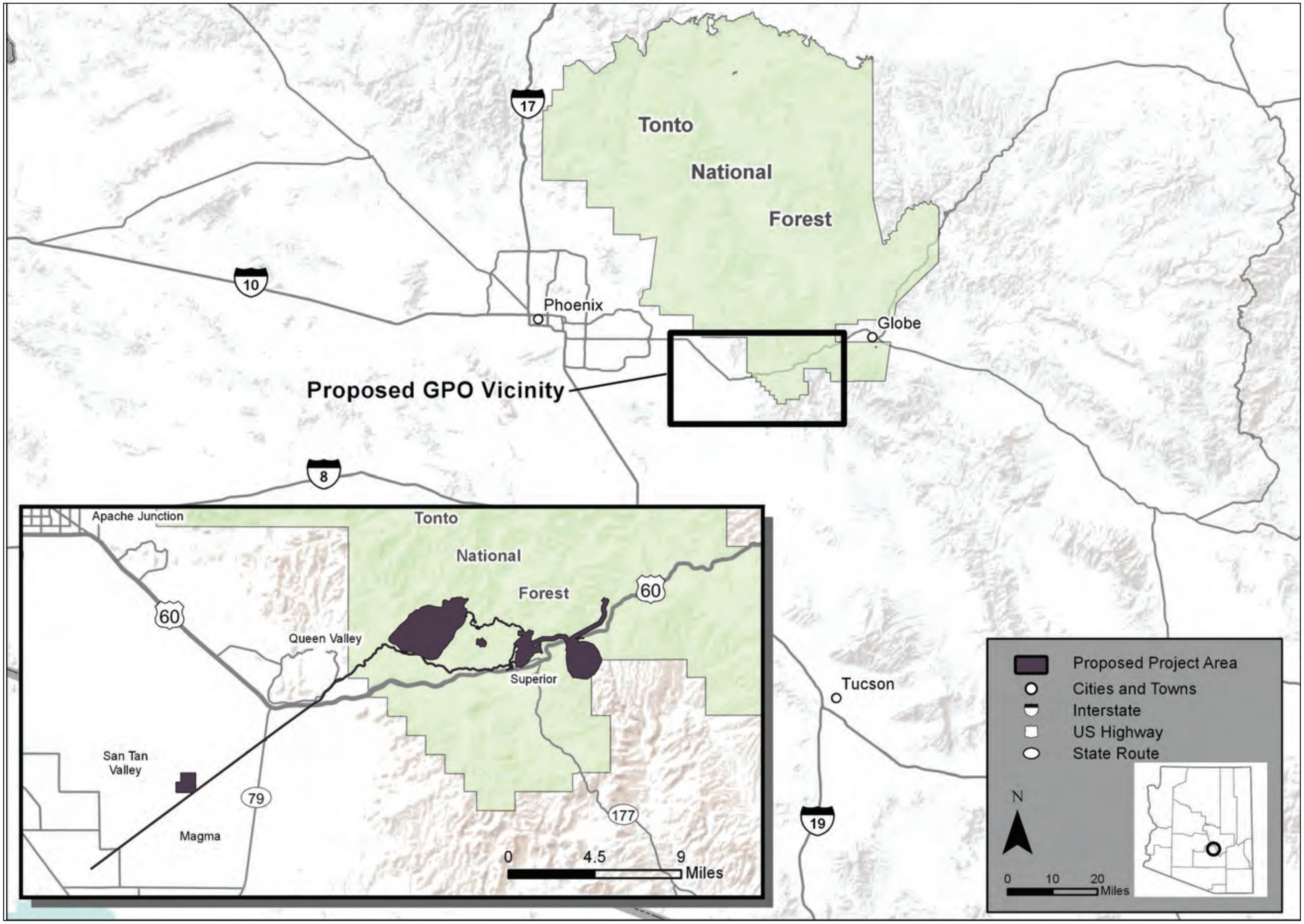

Figure 1.1-1. Resolution Copper Project vicinity map

proposed in the GPO, the mining portion of the project would occur on a mixture of private, State, and NFS lands.

However, in December 2014, Congress passed the Carl Levin and Howard P. 'Buck' McKeon National Defense Authorization Act for Fiscal Year 2015 (NDAA). Section 3003 of this law (appendix A) authorizes and directs the Secretary of Agriculture to administer an exchange of NFS lands, which would convey 2,422 acres of NFS land in the area of the proposed mine to Resolution Copper in exchange for approximately 5,344 acres[3] of private land on eight parcels located elsewhere in eastern Arizona (see section 1.4.2).

The offered private lands would be transferred from Resolution Copper to the United States, to be administered by the Forest Service and the U.S. Department of the Interior Bureau of Land Management (BLM). Upon completion of the land exchange, it is expected that one of the largest copper mines in the United States would be established on the exchange parcel, with an estimated surface disturbance of 6,951 acres[4] (approximately 11 square miles). It would also be one of the deepest mines in the United States, with mine workings extending 7,000 feet beneath the surface.

Section 3003 of the NDAA explicitly requires the Secretary of Agriculture to prepare an EIS prior to conveying the Federal land. This EIS shall be used as the basis for all decisions under Federal law related to the proposed mine, the GPO, and any related major Federal actions, including the granting of permits, rights-of-way, or the approvals for construction of associated power, water, transportation, processing, tailings, waste disposal, or other ancillary facilities.

Section 3003 of the NDAA requires this EIS to assess the effects of mining and related activities on such cultural and archaeological resources that may be located on the NFS lands conveyed to Resolution Copper, and identify measures that may be taken, to the extent practicable, to minimize potential adverse impacts on those resources, if any. The Secretary of Agriculture is further directed to engage in government-to-government consultation with affected Indian Tribes regarding issues of concern to the affected tribes related to the land exchange and, following such consultation, consult with Resolution Copper and seek to find mutually acceptable measures to address affected tribes' concerns and "minimize the adverse effects on the affected Indian Tribes resulting from mining and related activities on the Federal land conveyed to Resolution Copper" (see 16 United States Code [U.S.C.] 539p(c)(3)).

1.1.1 Document Structure

The Tonto National Forest prepared this EIS in compliance with the National Environmental Policy Act (NEPA) and other relevant Federal and State laws and regulations. This EIS discloses the direct, indirect, and cumulative environmental impacts that would result from the proposed action and alternatives.

This document has four volumes: volume 1, which contains an executive summary and chapters 1, 2, and the first portion of chapter 3; and volume 2, which contains the remainder of chapter 3 and chapters 4–8. Appendices are presented in volumes 3 and 4. The general contents of each volume follow.

1.1.1.1 Volume 1

- *Executive Summary*: Provides a brief overview of the contents of chapters 1 through 3 of the EIS.
- *Chapter 1. Purpose of and Need for Action*: Focuses on the underlying need to which the lead agency (Forest Service) is responding in proposing the action and alternatives, the

3. Resolution Copper increased the offered parcel by an additional 32 acres of privately held land that is adjacent to the 110 acres presented in the NDAA as part of the Apache Leap Special Management Area. The additional land was provided to allow for a more contiguous parcel and for ease of surveying.
4. This acreage includes a number of different facilities. See section 2.2.4 for full details.

framework in which decisions would be made, and the significant issues associated with the proposed action.

- *Chapter 2. Alternatives, Including the Proposed Action*: Describes the proposed action and four additional action alternatives considered in detail. These alternatives were developed based on significant issues raised by the public, Forest Service resource specialists, and other agencies. The no action alternative is included in the range of alternatives considered in detail. The chapter concludes with a summary that compares the environmental consequences of each alternative, based on the effects disclosed in chapter 3.
- *Chapter 3. Affected Environment and Environmental Consequences*: Describes the affected environment and the environmental consequences associated with the proposed action and the alternatives. The resources described under the affected environment headings represent baseline environmental conditions, incorporating past and present actions. Environmental consequences are the potential direct and indirect effects of each alternative on the affected environment. Reasonably foreseeable future actions (RFFAs) are considered in combination with the effects of each alternative to define the potential for cumulative effects. Any required mitigation measures are assessed, along with their effectiveness to reduce or offset impacts. Irreversible and irretrievable commitments of resources, the relationship between short-term uses and long-term productivity of the environment, and adverse environmental impacts that cannot be avoided are disclosed for each resource as well as in a section at the end of chapter 3. Chapter 3 provides the analyses for the comparison summary presented in chapter 2.

1.1.1.2 Volume 2

- *Chapter 3. Affected Environment and Environmental Consequences*: Continuation of Chapter 3 sections.
- *Chapter 4. Consulted Parties*: Identifies the Native American tribes, organizations, and Federal, State, and local government agencies and other parties consulted during the development of the EIS.
- *Chapter 5. List of Preparers:* This chapter lists the individuals who, under the supervision of the Forest Service, contributed to the preparation of the document and includes their organization, education, years of experience, and project role.
- *Chapter 6. Literature Cited*: Provides a list of literature cited in this document.
- *Chapter 7. Glossary; Acronyms and Abbreviations*: Provides definitions of terms used in this document.
- *Chapter 8: Index*: Indicates where keywords can be found within the document.

1.1.1.3 Volumes 3 and 4

- Each part of the appendix provides detailed information in support of the analyses and conclusions reported in the EIS. Volumes 3 and 4 contain the following appendices:
  - Appendix A: Section 3003 of the NDAA
  - Appendix B: Existing Conditions of Offered Lands
  - Appendix C: Draft Practicability Analysis in Support of Clean Water Act 404(B)(1) Alternatives Analysis
  - Appendix D: Draft Resolution Copper Project Clean Water Act Section 404 Conceptual Compensatory Mitigation Plan
  - Appendix E: Alternatives Impact Summary
  - Appendix F: Alternatives Considered but Dismissed from Detailed Analysis

- Appendix G: Further Details of East Plant Site, West Plant Site, MARRCO Corridor, and Filter Plant and Loadout Facility Infrastructure
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- Appendix O: Draft Programmatic Agreement Regarding Compliance with the NHPA on the Resolution Copper Project and Southeast Arizona Land Exchange

Additional project documentation, including more detailed analyses of project area resources, may be found in the project planning record, located at the Tonto National Forest Supervisor's Office, 2324 East McDowell Road, Phoenix, Arizona 85006.

1.2 Background

The area around Superior, Arizona, has a long mining history, starting with sporadic production of silver and gold from claims in the 1870s. The Silver King Mine, a few miles north of Superior, was the richest silver mine in Arizona, producing over 6 million dollars' worth of silver between 1877 and 1886. In 1902, George Lobb, Sr., a former level boss at the Silver King Mine, sold his group of claims to the

Main Street, Superior, ca. 1920, is paved but still without sidewalks. Photo courtesy of the Superior Sun.

Lake Superior and Arizona Mining Company and laid out the townsite which was named Superior. Later, William Boyce Thompson acquired the former Silver Queen mining property and organized the Magma Copper Company in 1910. The merger of Lobb's Golden Eagle claims with Thompson's Silver Queen claims allowed development of the Magma Copper Company mine. The original concentrator was built in 1914, and in 1915, the Magma Arizona Railroad went into operation to transport high-grade ore and concentrates to connect with the Phoenix & Eastern Railroad near Webster (later Magma Junction) and on to a smelter in Hayden. By 1920, the mine had increased in size and production to support construction of a smelter in Superior. The smelter began operating in 1924, including a roaster plant and a 300-foot stack. The highway through Queen Creek Gorge, providing direct travel between Superior and Globe, was completed by the Arizona Highways Department at about the same time.

The Magma Mine boomed in the late 1920s, producing more than 40 million pounds of copper in 1929. The Magma Mine survived the Great Depression on reduced workers' hours but returned to full production during World War II. Dewatering of the mine workings was required to allow access and production from the deeper underground shafts. Superior became one corner of Arizona's "Copper Triangle"—which stretched between the towns of Superior and Globe/Miami to the north and Hayden/Winkelman to the southeast—and which is the general location of more than 30 historical and active copper mines (figure 1.2-1). Mines and smelters in the area included ASARCO's Ray Mine, the Hayden Smelter, the Christmas Mine north of Winkelman, and a number of large open-pit mines in the Globe/Miami area (see figure 1.2-1).

The Magma Mine operated consistently until copper prices fell in the 1980s but reopened in the late 1980s before closing for good in 1996. In addition to substantial surface facilities in Superior, the Magma Mine left approximately 220,000 feet (42 miles) of underground workings.

Exploration from those underground workings led to the discovery of the Resolution deposit—deeper than the historic Magma Mine and a few miles south. The Resolution deposit is not exposed at the surface but lies between 4,500 and 7,000 feet below the surface. Existing workings from the Magma Mine have been repurposed to allow exploration of and access to the copper deposit.

According to the available geological data, the ore body is one of the largest undeveloped copper deposits in the world with an estimated copper resource of 1.787 billion metric tonnes at an average grade of 1.54 percent copper.

The portion of the copper deposit explored to date is located primarily on NFS lands. The ore body likely extends underneath a 760-acre area of NFS land identified in the NDAA as the "Oak Flat Withdrawal Area." The Oak Flat Withdrawal Area was withdrawn from mineral entry in 1955 by Public Land Order 1229; consequently, the GPO does not propose to extract minerals from or conduct mining operations on these lands.

However, for more than 10 years, Resolution Copper pursued a land exchange to acquire adjacent lands northeast of the copper deposit. In December 2014, Congress authorized a land exchange pending completion of the EIS; the exchange parcel to be conveyed to Resolution Copper includes not only the Oak Flat Withdrawal Area but also the NFS lands above which the copper deposit is located. This collective 2,422-acre area of land is known as the "Oak Flat Federal Parcel."

The land ownership of the project area includes surface land administered by the Forest Service or BLM with Resolution Copper–controlled unpatented mining and/or mill site claims; Resolution Copper–owned private land; lands where Resolution Copper controls the patented mining claims; as well as lands with unpatented lode claims not controlled by Resolution Copper. Additional information on claims can be found in section 3.2.3.2.

The land surface overlying the copper deposit is located in an area that has a long history of use by Native Americans, including the Apache, O'odham, Puebloan, and Yavapai people currently represented by the following federally recognized tribes: Fort McDowell Yavapai Nation, Gila River Indian Community, Hopi Tribe, Mescalero Apache Tribe, Pueblo of Zuni, Salt River Pima-Maricopa Indian Community, San Carlos Apache Tribe, Tonto Apache Tribe, White Mountain Apache Tribe, Yavapai-Apache Nation, and Yavapai-Prescott Indian Tribe. The Forest Service maintains formal and informal consultations with these tribes and other interested and affected parties to better understand the historical, cultural, and religious importance of the area.

1.3 Purpose of and Need for Action

The purpose of and need for this project is twofold:

1. To consider approval of a proposed mine plan governing surface disturbance on NFS lands outside of the exchange parcels from mining operations that are reasonably incident to extraction, transportation, and processing of copper and molybdenum.

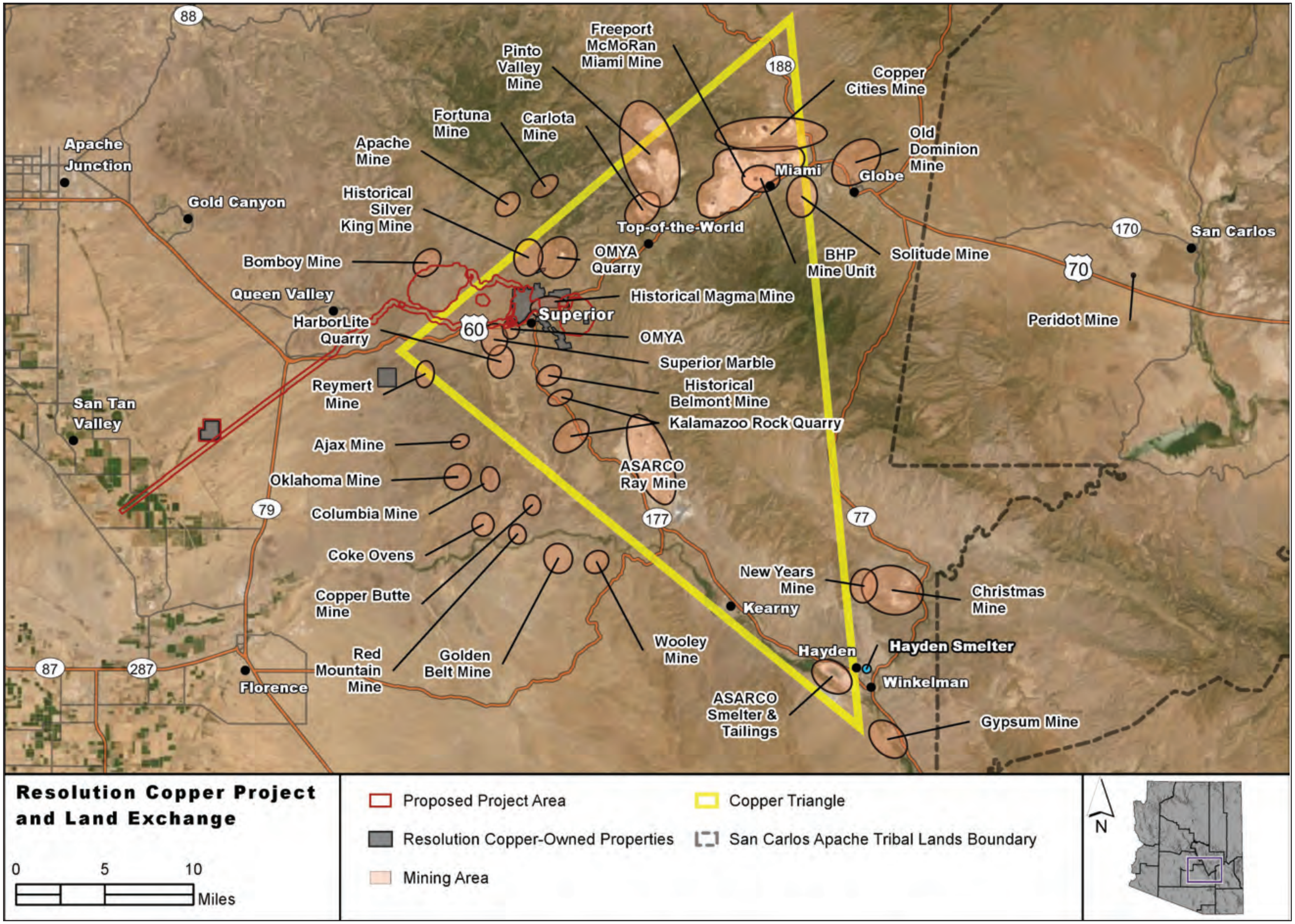


Figure 1.2-1. The Copper Triangle map

2. To consider the effects of the exchange of lands between Resolution Copper and the United States as directed by Section 3003 of the NDAA.

The role of the Forest Service under its primary authorities in the Organic Administration Act, Locatable Minerals Regulations (36 Code of Federal Regulations [CFR] 228 Subpart A), and the Multiple-Use Mining Act is to ensure that mining activities minimize adverse environmental effects on NFS surface resources and comply with all applicable environmental laws. The Forest Service may also impose reasonable conditions to protect surface resources. Through the Mining and Mineral Policy Act, Congress has stated that it is the continuing policy of the Federal Government, in the national interest, to foster and encourage private enterprise in

- the development of economically sound and stable domestic mining, minerals, and metal and mineral reclamation industries; and
- the orderly and economic development of domestic mineral resources, reserves, and reclamation of metals and minerals to help ensure satisfaction of industrial, security, and environmental needs.

The Southeast Arizona Land Exchange and Conservation Act was included in a large public lands package containing 68 bills which was amended to the NDAA during the 113th Congress. The NDAA was signed into law by President Obama on December 19, 2014. Under the Southeast Arizona Land Exchange and Conservation Act, Resolution Copper would receive 2,422 acres of Federal land at the site of the future underground copper mine in exchange for 5,376 acres of privately owned conservation and recreation lands throughout Arizona after the completion of a final EIS (FEIS). While the mine itself would be located on private land after the exchange is completed, ancillary mining operations would need to occur on NFS land, and possibly other Federal and non-Federal land, outside of the exchange parcel.

1.4 Proposed Action

The proposed action consists of (1) approval of a mining plan of operations on NFS land associated with a proposed large-scale mine, which would be on private land after the land exchange, (2) the NDAA-directed land exchange between Resolution Copper and the United States, and, if needed, (3) amendment of the forest plan.

It should be noted that the proposed action is one of several alternatives considered in the draft EIS (DEIS). The proposed action should not be confused with the preferred alternative. The preferred alternative is identified in the executive summary and chapter 2 and is the agency's preference for implementation based on the alternatives evaluated and the current analysis.

1.4.1 General Plan of Operations

The following is a brief summary of the mining proposal components. A detailed description of the GPO can be found in section 2.2.2.2. The complete GPO is available on the project website, www.ResolutionMineEIS.us.

Resolution Copper proposes to conduct underground mining of a copper-molybdenum deposit located 4,500 to 7,000 feet below the ground surface within the exchange parcel. Resolution Copper estimates that the mine would take approximately 10 years to construct, would have an operational life of approximately 41 years (mine years 11 to 51), and would be followed by 5 to 10 years (mine years 52 to 57 or 62) of reclamation activities.

The mining operation would include the following facilities and activities analyzed in the EIS, which would be conducted on a mixture of NFS, private, and State lands:

- The mining itself would take place under the Oak Flat Federal Parcel, which is to be transferred to Resolution Copper

pursuant to Section 3003 of the NDAA. Mining would use an underground mining technique known as panel caving. Resolution Copper would use this process to construct a network of shafts and tunnels below the ore body. They would access the tunnels from vertical shafts in an area known as the East Plant Site. The panel caving technique fractures ore with explosives; gravity moves the ore downward, and then Resolution Copper removes it from below the ore deposit. As the ore moves downward and is removed, the land surface above the ore body also moves downward or "subsides." Analysts expect a "subsidence" zone to develop near the East Plant Site; there is potential downward movement to a depth between 800 and 1,115 feet. Resolution Copper projects the subsidence area to be up to 1.8 miles wide at the surface.

- An area known as the East Plant Site would be developed adjacent to the Oak Flat Federal Parcel. The East Plant Site is the location of the Magma Mine #9 Shaft and #10 Shaft and associated surface mining support facilities. This area would include mine shafts and a variety of surface facilities to support mining operations. This area currently contains two operating mine shafts, a mine administration building, and other mining infrastructure. Existing roads would provide access to the mine. Magma Mine Road would eventually be relocated as a result of the expected subsidence.[5]
- Resolution Copper would crush the mined ore underground and then transport it underground approximately 2.5 miles west to an area known as the West Plant Site. There, operations would process the ore to produce copper and molybdenum concentrates. The West Plant Site is the location of the old Magma Mine processing and smelter facilities in Superior. Portions of the West Plant Site would be located on NFS lands and would be subject to Forest Service regulatory jurisdiction. A flotation process would process the ore; no heap leach processing is proposed.
- The molybdenum concentrate would then be dried, bagged, and transported to market from the West Plant Site.
- Resolution Copper would then pump the copper concentrate as a slurry through a 22-mile-long pipeline to a filter plant and loadout facility located near Magma Junction near San Tan Valley, Arizona. They would then filter the copper concentrate and send it to off-site smelters via rail cars or trucks.
- The copper concentrate slurry pipeline corridor would be located along an existing, previously disturbed right-of-way known as the Magma Arizona Railroad Company (MARRCO) corridor. The MARRCO corridor would also host other mine infrastructure, including water pipelines, power lines, pump stations, and a number of wells for groundwater pumping and recovery of banked Central Arizona Project (CAP) water. A portion of the MARRCO corridor is located on NFS, Arizona State Land Department (ASLD), and private lands and would be subject to corresponding regulatory jurisdiction.
- Several pipelines would transport the tailings as slurry produced at the West Plant Site for 4.7 miles to a tailings storage facility. The tailings storage facility would gradually expand over time and eventually reach about 4,900 acres in size. The proposed tailings storage facility is on NFS lands and would be subject to Forest Service regulatory jurisdiction.
- The Salt River Project (SRP) would supply all power to the mine. Portions of the proposed electrical infrastructure would be on NFS land and would be subject to Forest Service regulatory jurisdiction. The Forest Service can approve SRP's construction and operation of new power lines on NFS lands by either a special use permit or as part of the GPO. As analyzed in the EIS, access to the power lines would use existing roads.
- Reclamation would be conducted to achieve post-closure land use objectives, including closing and sealing the mine shafts,

5. A full description of subsidence can be found in section 2.2.2.2.

removing surface facilities and infrastructure, and establishing self-sustaining vegetative communities using local species. The proposed tailings storage facility would be reclaimed in place, providing for permanent storage of mine tailings. A bond conditioned on compliance is required prior to approval of a mining plan of operations. In determining the amount of the bond, consideration would be given to the estimated cost of stabilizing, rehabilitating, and reclaiming the area of operations.

- Water for the process would come from a variety of sources. Resolution Copper would recycle (1) filtrate from the filter plant, (2) reclaimed water from the tailings storage facility, and (3) recovered water from the concentrator complex, back into the mining process. They would obtain additional water from dewatering of the mine workings, possible direct delivery of CAP water, and pumping of water from a well field along the MARRCO corridor. The State of Arizona would authorize the water pumped from the well field either as banked CAP water or as groundwater under a mineral extraction withdrawal permit.

1.4.2 Land Exchange

Following Section 3003 of the NDAA, the Federal Government would convey 2,422 acres of specified NFS lands at Oak Flat to Resolution Copper if Resolution Copper offers to convey approximately 5,376 acres[6] of private lands to the United States. Table 1.4.2-1 provides a brief summary of the land exchange parcels. A detailed description of the land exchange parcels can be found in section 2.2.2.1 and appendix B. The complete text of Section 3003 of the NDAA is provided in appendix A.

1.4.2.1 Appraisal

The exchange of Federal lands is subject to a formal appraisal for all tracts of land included in an exchange. Additionally, the NDAA requires that exchanged private lands be of equal value to the Federal lands. The NDAA requires the joint selection of an appraiser who is determined by both parties (the Federal Government and Resolution Copper) to be qualified to complete appraisals supporting the exchange. The appraisals are completed under the direction of the Forest Service.

If an appraisal indicates that the value of the Federal lands exceeds the value of the private lands, Resolution Copper must either provide more private land or provide cash to the Federal Government to make up the difference. If a cash payment is used to equalize the values, that money would be placed in a special account to be used for acquisition of additional NFS land in Arizona or New Mexico. An additional provision of the NDAA requires Resolution Copper to make annual payments to the Federal Government during mine production in the event that the appraisal undervalues the copper resource on the lands Resolution Copper is acquiring.

1.4.3 Forest Plan Amendment

Forest plans provide broad, program-level direction for management of NFS lands and resources. As directed by Forest Service regulations at 36 CFR 219.13 forest plans can be amended as needed to accommodate situations in specific project decisions or to reflect changes in social, economic, or ecological conditions.

A consistency review between the GPO and the current forest plan indicates that approval and eventual implementation of the GPO would result in changed conditions that are inconsistent with existing forest plan direction. Approval of the GPO would therefore require a project-specific forest plan amendment to modify one or more plan components, i.e., standards and guidelines. The scope and scale of the necessary forest plan amendment would be narrow in scope and scale, i.e., limited to the GPO project area; and limited to the substantive rule provisions at §219.10 that are directly related to the amendment.

6. Resolution Copper increased the offered parcel of 5,344 acres by anadditional 32 acres of privately held land. See table 1.4.2-1.

Table 1.4.2-1. Summary of land exchange parcels

Parcel Land Ownership	Description of Parcels to Be Exchanged
Parcels transferred from the United States to Resolution Copper	2,422 acres near Superior in Pinal County, Arizona, known as the **Oak Flat Federal Parcel,** to become private lands
Parcels transferred from Resolution Copper to the Secretary of Agriculture, for land to be administered by the Forest Service	142 acres* near Superior in Pinal County, Arizona, known as the **Apache Leap South End Parcel**, to be administered by the Tonto National Forest 148 acres in Yavapai County, Arizona, known as the **Tangle Creek Parcel**, to be administered by the Tonto National Forest 147 acres in Gila County, Arizona, known as the **Turkey Creek Parcel**, to be administered by the Tonto National Forest 149 acres near Cave Creek in Maricopa County, Arizona, known as the **Cave Creek Parcel**, to be administered by the Tonto National Forest 640 acres north of Payson in Coconino County, Arizona, known as the **East Clear Creek Parcel**, to be administered by the Coconino National Forest
Parcels transferred from Resolution Copper to the Secretary of the Interior, for land to be administered by the BLM	3,050 acres† near Mammoth in Pinal County, Arizona, known as the **Lower San Pedro River Parcel**, to be administered by the BLM as part of the San Pedro Riparian National Conservation Area 940 acres† south of Elgin in Santa Cruz County, Arizona, known as the **Appleton Ranch Parcel**, to be administered by the BLM as part of the Las Cienegas National Conservation Area 160 acres near Kearny in Gila and Pinal Counties, Arizona, known as the **Dripping Springs Parcel**, to be administered by the BLM

*Resolution Copper increased the offered parcel by an additional 32 acres of privately held land adjacent to the 110 acres presented in the NDAA as part of the Apache Leap Special Management Area. The additional land was provided to allow for a more contiguous parcel and for ease of surveying.

† Final cadastral surveys have not been finalized for either the Lower San Pedro River Parcel or the Appleton Ranch Parcel as of July 2019.

A review of all components of the 1985 forest plan, as amended through 2017, was conducted to identify the need for amendment due to the effects of the project, including both the land exchange and the proposed mine plan. Specific findings on the effects of the forest plan amendment are summarized under the environmental consequences section for each resource in chapter 3.

Summarily, the outcomes of the 1985 forest plan consistency review indicate that amendments would be needed under any alternative to reconcile the Visual Quality Objective (VQO) and recreation opportunity spectrum (ROS) management classes for two standards and guidelines in Management Areas 2F and 3I (table 1.4.3-1). Information specific to the 184 forest plan components that were identified as applicable are detailed in Shin (2019).

The plan components that would need to be amended to comply with the existing 1985 forest plan are described in table 1.4.3-1.

1.5 Decision Framework

Given the purpose and need, the deciding official(s) reviews the proposed action, the other alternatives, and the environmental consequences in order to make the following decisions.

1.5.1 Forest Service

As the lead agency tasked with completion of a single EIS, the Forest Service has management responsibility for the following:

- The NFS lands that would be affected by the proposed GPO
- Executing the land exchange that was mandated by Congress
- Approve necessary amendments to the forest plan (see section 1.4.3).

Table 1.4.3-1. Forest plan amendments for the Resolution Copper Project and Land Exchange

Forest Plan Section	1985 Forest Plan Page Number	Existing Forest Plan	Proposed Forest Plan Amendment
Section 4. Management Direction Management Prescriptions – Globe Ranger District (Management Area 2F)	85	Manage for VQOs ranging from “Retention” to “Maximum Modification” according to the following guidelines: Retention = 8%, Partial Retention = 24%, Modification = 34%, and Maximum Modification = 34%.	Manage for VQOs ranging from “Retention” to “Maximum Modification” according to the following guidelines: Retention = 9%, Partial Retention = 35%, Modification = 31%, Maximum Modification = 21%, and Not Rated = 4%.
Section 4. Management Direction Management Prescriptions – Globe Ranger District (Management Area 2F)	86	Manage ROS Classes (see appendix E of the forest plan) according to existing inventory as follows: Semi-Primitive = 35%, Semi-Primitive Motorized = 39%, Roaded Natural = 24%, Rural = 1%, and Urban = 1%.	Manage ROS Classes (see appendix E of the forest plan) according to existing inventory as follows: Semi-Primitive = 17%, Semi-Primitive Motorized = 55%, Roaded Natural = 23%, Rural = 2%, and Urban = 3%.
Section 4. Management Direction Management Prescriptions – Mesa Ranger District (Management Area 3I)	112	Manage for VQOs ranging from “Retention” to “Maximum Modification” according to the following guidelines: Retention = 15%, Partial Retention = 40%, Modification = 35%, and Maximum Modification = 10%.	Manage for VQOs ranging from “Retention” to “Maximum Modification” according to the following guidelines: Retention = 23%, Partial Retention = 45%, Modification = 27%, Maximum Modification = 2%, and Not Rated = 3%.
Section 4. Management Direction Management Prescriptions – Mesa Ranger District (Management Area 3I)	113	Manage ROS Classes (see appendix E of the forest plan) according to existing inventory as follows: Primitive = 1%, Semi-Primitive = 42%, Semi-Primitive Motorized = 36%, Roaded Natural = 21%.	Manage ROS Classes (see appendix E of the forest plan) according to existing inventory as follows: Semi-Primitive = 26%, Semi-Primitive Motorized = 48%, Roaded Natural = 26%, Rural = 0%, and Urban = 0%.

1.5.1.1 General Plan of Operations

The Forest Supervisor, Tonto National Forest, is the deciding official and has discretion to determine whether changes in the proposed GPO would be required prior to approval.

Regulations that govern the use of surface resources in conjunction with mining operations on NFS lands are set forth under 36 CFR 228 Subpart A. These regulations require that the Forest Service respond to parties who submit proposed plans to conduct mining operations on or otherwise use NFS lands in conjunction with mining. Compliance with other laws and regulations, such as State of Arizona water and air regulations, the Endangered Species Act (ESA), Clean Water Act (CWA), and National Historic Preservation Act (NHPA), also frames the proposed mining activities.

The Forest Supervisor would use analysis in this EIS along with supporting documentation to make the following decisions regarding the proposed GPO:

1. Approve the proposed GPO submitted by Resolution Copper or require changes or additions to the proposed GPO to meet the requirements for environmental protection and reclamation set forth at 36 CFR 228 Subpart A before approving a final GPO. The Forest Service decision may be to authorize use of the surface of NFS lands in connection with mining operations under the GPO composed of elements from one or more of the alternatives considered. The alternative(s) that is/are selected for approval in the final ROD must minimize adverse impacts on NFS surface resources to the extent feasible.
2. Whether to approve amendments to the forest plan, which may be required to approve the final GPO.
3. Whether to approve a special use permit for SRP to authorize construction and operation of power lines on NFS lands.

The Forest Supervisor would then release a draft ROD in conjunction with the FEIS that would address these three decisions. The draft ROD would be subject to 36 CFR 218, "Project-Level Pre-decisional Administrative Review Process" and 36 CFR 219, "Planning-Level Pre-decisional Administrative Review Process."

Once objections to the draft ROD are resolved, the Forest Supervisor would issue a final ROD. Resolution Copper may have an opportunity to appeal the decisions as set forth at 36 CFR 214, "Post decisional Administrative Review Process for Occupancy and Use of National Forest System Lands and Resources."

The remaining step would be approval of a final GPO, which may require Resolution Copper to modify the proposed GPO to align it with (1) the description of the selected alternative in the final ROD, and (2) changed conditions mandated by Section 3003 of the NDAA. Additionally, the Forest Supervisor, Tonto National Forest, would require Resolution Copper to submit a reclamation bond or other financial assurance to ensure that NFS lands and resources involved with the mining operation are reclaimed in accordance with the approved GPO and Forest Service requirements for environmental protection (36 CFR 228.8 and 228.13). After the Forest Service has determined that the GPO conforms to the ROD and that the reclamation bond is acceptable, it would approve the GPO. Implementation of mining operations that affect NFS lands and resources may not commence until a plan of operations is approved and the reclamation bond or other financial assurance is in place.

1.5.1.2 Land Exchange

With regard to the land exchange, the Tonto National Forest Supervisor, has no decision authority due to the constraints imposed by the NDAA. The Forest Supervisor does have a responsibility to (1) address concerns of affected Indian Tribes and see mutually acceptable resolution of concerns with Resolution Copper; (2) ensure that title to the non-Federal lands offered in the exchange is acceptable in accordance with Section 3003(c)(2)(A) of the NDAA; and (3) accept additional non-Federal land or a cash payment from Resolution Copper to the United States in the event that the final appraised value of the Federal land exceeds the value

of the non-Federal land in accordance with Section 3003(c)(5)(B)(i) of the NDAA.

Environmental effects resulting from the land exchange on private, State, and NFS lands are analyzed in the EIS. Although the Forest Service no longer would have regulatory jurisdiction for those lands, Resolution Copper would still be required to comply with applicable Federal and State environmental laws, which address air quality, hazardous waste management, mine safety, mine reclamation, and other aspects of the proposed mine.

1.5.2 Bureau of Land Management

The NDAA-directed land exchange would transfer ownership of approximately 4,150 acres of Resolution Copper private lands to the BLM. As with the Forest Service, the BLM has no decision authority with respect to the land exchange.

The BLM would incorporate and administer the land acquired for the Lower San Pedro River Parcels into the San Pedro National Conservation Area no later than 2 years after the date on which the land is acquired. The San Pedro Riparian National Conservation Area Resource Management Plan would be updated to reflect the acquired land.

The BLM would incorporate and administer the land acquired for the Dripping Springs Parcel into the Las Cienegas National Conservation Area in accordance with the Federal Land Policy and Management Act of 1976 (FLPMA), laws (including regulations) applicable to the Las Cienegas National Conservation Area, and applicable land use plans.

For purposes of this analysis, the Forest Service has identified an alternative that includes siting mine facilities on BLM-administered land, rather than on NFS lands as proposed by Resolution Copper (see section 2.2.7 for a description of Alternative 5 – Peg Leg). If the Forest Service were to select Alternative 5 – Peg Leg, the Forest Service's selection of that alternative would not authorize surface use of any BLM-managed public lands. In order to use the public lands identified in Alternative 5 – Peg Leg, Resolution Copper would be required to obtain surface use authorization under the applicable BLM regulations. BLM would require the submittal of a separate mining plan of operations to determine whether unnecessary or undue degradation would occur (43 CFR 3809.11(a)). BLM would then issue a separate ROD from the Forest Service to approve mine-related actions on BLM-administered lands and would need to conduct any administrative review processes required under BLM regulations; this would include review of conformance with any current management plans. The BLM ROD would not necessarily be issued at the same time as the Forest Service ROD. Additional tribal and public involvement might also be required to satisfy BLM regulations if the Alternative 5 – Peg Leg alternative were selected. To date, Resolution Copper does not have any pending requests for surface use authorization before BLM.

1.5.3 U.S. Army Corps of Engineers

Selection of some, but not all, of the alternatives would require the U.S. Army Corps of Engineers (USACE) to issue a permit under Section 404 of the Clean Water Act, which regulates discharge of dredged and fill within waters of the U.S. The USACE previously evaluated drainages and wetlands in portions of the Superior Basin associated with this project and found these aquatic features were not subject to the USACE's jurisdiction under current rules. For drainages to be under the jurisdiction of the USACE, they must have a "significant nexus" to a traditionally navigable water. In 2012, the USACE determined that the drainages within the Superior Basin do not have a significant nexus to the closest traditionally navigable water, which is the Gila River between Powers Butte and Gillespie Dam. Ultimately, this determination means that a tailings storage facility sited within these areas in the Superior Basin (Alternative 2, 3, or 4; see section 2.2) would not need a Section 404 permit, whereas other alternatives would require one (Alternative 5 or 6).

Because Congress directed that the EIS serves to support all Federal decisions related to the proposed mine, if Alternative 5 or 6 were ultimately selected, the USACE would rely on this EIS to support issuance of a Section 404 permit. In accordance with the Clean Water

Act, Section 404(b)(1) guidelines (40 CFR 230), the USACE may only permit the least environmentally damaging practicable alternative in light of cost, logistics, and technology. A draft Practicability Analysis has been prepared for the range of alternatives originally considered for this project using the criteria in the Section 404(b)(1) guidelines and has been included with this EIS as appendix C. This document will be refined during this EIS process and used by USACE to select a least environmentally damaging practicable alternative and support USACE's permitting decision.

A permittee is also required to compensate for the loss of waters of the U.S. in accordance with 33 CFR 332. Appendix D of this EIS contains Resolution Copper's draft Conceptual Compensatory Mitigation Plan.

Based on the analysis in this EIS and supporting documentation, the USACE's public interest review, and the determination of the least environmentally damaging practicable alternative in the Section 404(b)(1) alternatives analysis, the USACE would determine whether to do one of the following:

1. Issue Resolution Copper a CWA Section 404 individual permit for the discharge of dredged and/or fill material into waters of the U.S.; or
2. Issue Resolution Copper a CWA Section 404 individual permit with modifications or special conditions; or
3. Deny the CWA Section 404 individual permit.

The USACE would issue a public notice during the DEIS comment period and would consider all comments received in response to the public notice, the DEIS, and public hearings (if applicable) as part of the public interest review. Following issuance of the FEIS, the USACE would prepare a ROD, separate from the Forest Service, regarding the Section 404 permit. The USACE's administrative appeals process allows the applicant to appeal a denied permit or a proffered permit that the applicant has declined. Details on this process are contained in 33 CFR 331, "Administrative Appeals Process."

1.5.4 Required Permits, Licenses, and Authorizations

Other permits, licenses, and authorizations would be required for the mine to be operational. Additional Special Use Permits and rights-of-way may also be needed for power lines built by SRP, access roads, or other features. The EIS would not determine if a permit through another agency would be approved but would disclose impacts for resources analyzed. Table 1.5.4-1 provides the permits and licenses commonly required for this type of project; it is not meant to be a comprehensive list of all possible permit(s), license(s), or authorization(s) needed. A list of existing Resolution Copper permits and licenses currently held for ongoing operations is shown in table 1.4.2 of the GPO.

1.5.5 Financial Assurance for Closure and Post-closure Activities

The Forest Service mission of promoting healthy and resilient forests and grasslands is a key component for ensuring that the lands and resources the Forest Service manages are available for future generations. Mineral development on NFS lands is a temporary use of those lands, although some uses like tailings storage facilities are permanent and remain part of the landscape in perpetuity. Reclamation of mining sites is an integral part of all mine plans considered by the Forest Service, as is the requirement that adequate fiscal resources be available to ensure that reclamation can be conducted.

The primary authority for the Forest Service to require financial assurance is contained in the locatable mineral regulations (36 CFR 228 Subpart A). These include the requirement for a plan of operations to include provisions for reclamation: "The plan of operation shall include . . . measures to be taken to meet the requirements for environmental protection. . . ." (36 CFR 228.4). The regulations include specific requirements for financial assurance: "Any operator required to file a plan of operations shall, when required by the authorized officer, furnish a bond conditioned upon compliance with 228.8(g), prior to approval of such plan of operations" (36 CFR 228.13). The amount of financial

Table 1.5.4-1. Permits, licenses, and authorizations required for the Resolution Copper Project

Type of Permit	Permitting Agency	Permit Use
Aquifer Protection Permit (APP)	Arizona Department of Environmental Quality	An APP is required for any activity that discharges a pollutant to an aquifer, or to the land surface so that there is a reasonable probability that the pollutant would reach an aquifer. General APPs are available for some impoundments and facilities, as long as they have characteristics specified by Arizona regulations (like lining). Resolution Copper currently holds a number of general APPs for wash bays (type 3.02 permits), wastewater treatment discharges (type 3.03 permits), and rock stockpiles (type 2.02 permits). Resolution Copper also currently holds an Individual Industrial Reclaimed Water APP, which allows conveyance of treated water to the New Magma Irrigation and Drainage District (NMIDD) for agricultural application (alfalfa, barley, Bermudagrass, cotton, sorghum, turf, and wheat). A similar permit would be required during operations for any treated water discharged to NMIDD. Resolution Copper also holds an area-wide APP that authorizes the closure of existing APP-regulated facilities at the West Plant Site under a compliance schedule, and an individual APP for a non-municipal solid waste landfill, which is approved to accept construction and demolition debris, non-hazardous mine refuse, vegetative waste, non-tire rubber products, solid waste petroleum-contaminated soil, metal-contaminated soil, empty containers, and nonfriable and friable asbestos-containing material. For operations, Resolution Copper would require an Individual APP that would encompass all mining and processing activities with the potential to discharge, most notably the tailings storage facility. The specific project components requiring permitting through the Individual APP are not yet determined.
Special Waste Facility Generator	Arizona Department of Environmental Quality	Resolution Copper is authorized to handle wastes designated as “special wastes” by the State.
Drinking Water Division Monitoring Assistance Program	Arizona Department of Environmental Quality	Public water system for serving potable groundwater to Resolution Copper employees.

continued

Table 1.5.4-1. Permits, licenses, and authorizations required for the Resolution Copper Project *(cont'd)*

Type of Permit	Permitting Agency	Permit Use
Arizona Pollutant Discharge Elimination System (AZPDES) Permit	Arizona Department of Environmental Quality	The State of Arizona has received jurisdiction (also known as "primacy") to administer Section 402 of the Clean Water Act, which is accomplished through the AZPDES program. Section 402/AZPDES regulates any discharges of pollutants to waters of the U.S., including potential pollutants in stormwater runoff. Any direct discharge of a pollutant into a water typically requires an individual AZPDES permit. Resolution Copper currently holds an AZPDES permit to discharge treated mine site stormwater runoff (Outfall 001) and treated seepage pumping and mine dewatering effluent (Outfall 002) to Queen Creek. The discharge must be in accordance with effluent limitations, monitoring requirements, and other conditions in the Standard Arizona Pollutant Discharge Elimination System Permit Conditions. The Arizona Department of Environmental Quality (ADEQ) has also issued a multi-sector general permit, which covers stormwater discharges from common industrial activities. Typically, a permittee would apply for coverage under the Multi-Sector General Permit (MSGP) program, and develop a Stormwater Pollution Prevention Plan (SWPPP) detailing how stormwater would be handled to reduce the potential for pollutants, including sediment. Resolution Copper currently is authorized under the MSGP for stormwater discharges from both the West Plant Site and East Plant Site. During operations, stormwater discharges from mine facilities most likely would take place under the MSGP program. Temporary stormwater discharges may also be covered under the construction general permit, which has similar requirements as the MSGP program. Certain temporary discharges (such as pump testing of a well) may also be covered under the de minimis permit program. The specific AZPDES permits required for construction and operation would be determined by ADEQ.
Clean Water Act Section 401 Water Quality Certification	Arizona Department of Environmental Quality	The State must certify, waive, or deny an application for a USACE permit for discharge of dredged or fill material to waters of the U.S. To certify, the State must find that the activities proposed under the 404 permit would not result in a violation of State surface water quality standards. The 401 certification may specify conditions, including reporting requirements.
Solid Waste Plan Approval	Arizona Department of Environmental Quality	Required to meet the requirements of 40 CFR 257, along with other requirements set forth in State statutes (e.g., compliance with location restrictions, recording of a restrictive covenant).
Hazardous Waste Management Program	Arizona Department of Environmental Quality	Governs the management of hazardous waste (including transport and disposal). Requirements differ somewhat, depending on the volume and nature of hazardous waste generated; however, in general, it requires inspection, training, and contingency/emergency planning.
Drinking Water Registration and Regulations	Arizona Department of Environmental Quality	Systems (including nontransient, noncommunity systems) must register with ADEQ and meet substantive requirements. Requires inspection, sampling/analysis, contingency/emergency planning, reporting, and notification.

continued

Table 1.5.4-1. Permits, licenses, and authorizations required for the Resolution Copper Project *(cont'd)*

Type of Permit	Permitting Agency	Permit Use
Groundwater Permits	Arizona Department of Water Resources	Groundwater pumping and use is regulated heavily within Active Management Areas (AMAs), which are areas of intensive water use, originally identified in the Arizona Groundwater Management Act of 1980. The locations of pumping for dewatering (Shafts 9 and 10) and the future makeup water supply (Desert Wellfield) lie within the East Salt River valley subbasin of the Phoenix AMA. Within the AMA, pumping groundwater requires a valid groundwater right, or a valid withdrawal permit. Resolution Copper currently holds several groundwater rights: Type 2 Non-Irrigation Grandfathered Rights/Type II Mineral Extraction Rights, and a dewatering withdrawal permit. Similar rights or permits would be required for any dewatering that occurs during operations. Resolution Copper would be required to permit any wells associated with the Desert Wellfield, which would lie within the MARRCO corridor. Notices of Intent to Drill would be required for any well installation, to ensure proper construction and documentation. Any further permits or rights required would depend on whether water pumped was legally considered recharged or banked water, or regular groundwater. This would be determined by the Arizona Department of Water Resources.
Special Land Use Permit	Arizona State Land Department	Resolution Copper holds several permits for geotechnical and hydrological data gathering, installation of surface water monitoring equipment, and groundwater monitor well installation and access. These permits may or may not be required during operations.
Right-of-Way Permit	Arizona State Land Department	Allows water and electrical supply lines to be placed within a right-of-way. Permit would be issued after the Arizona Corporation Commission approves the electrical supply alignment.
Arizona Mined Land Reclamation Plan Approval	Arizona State Mine Inspector	Applies to reclamation activities at the site. Requires certification, plan updates, annual reporting, and financial assurance. Resolution Copper currently holds a plan authorizing the reclamation of surface disturbances at the East and West Plant Sites.
Certificate of Environmental Compatibility	Arizona Corporation Commission, Line Siting Committee	Ensures compliance with Arizona Revised Statutes (ARS) 40-360 and regulates the placement of electrical transmission lines.
Agriculture Land Clearing Permit	Arizona Department of Agriculture	Authorizes disturbance and clearing of State-protected native plants, as required under the Arizona Native Plant Law.
Right-of-Way Encroachment Permit	Arizona Department of Transportation	Authorizes work within the State right-of-way, such as highways, driveways, grading, fence removal or replacement, surveying, and geotechnical investigation.
Final Mining Plan of Operations (after publication of the FEIS and approval of the ROD)	U.S. Forest Service	A final mining plan of operations would be required to be approved by the Forest Supervisor. Approval of the final mining plan provides the authorization to conduct activities on NFS lands. The final mining plan must reflect requirements specified in the ROD, including mitigation, monitoring, reporting, requirements of all applicable permits and authorizations, and is accompanied by posting of a bond or other financial assurance.

continued

Table 1.5.4-1. Permits, licenses, and authorizations required for the Resolution Copper Project *(cont'd)*

Type of Permit	Permitting Agency	Permit Use
Baseline Hydrologic and Geotechnical Data Gathering Activities Plan of Operations	U.S. Forest Service	To collect hydrologic, geochemical, and geotechnical data in order to provide baseline information on these aspects of the environment over an area being considered at the Near West site. These activities are complete.
Special Use Permit	U.S. Forest Service	The existing Special Use Permit authorizes Resolution Copper to construct and maintain a water pipeline corridor from the water treatment plant to an irrigation canal operated by the NMIDD. Future activity within the MARRCO corridor potentially could be covered under the final mining plan of operations, rather than a special use permit.
Mining Plan of Operations and Record of Decision	Bureau of Land Management	In the event Alternative 5 – Peg Leg is selected, Resolution Copper's GPO would be denied with respect to the facilities proposed on NFS lands that are identified to be placed on BLM-managed public lands, State lands, or private lands. To use BLM-managed public lands, Resolution Copper would need to obtain surface use authorization from BLM in accordance with BLM's surface management regulations 43 CFR subpart 3809. BLM would then issue a separate ROD from the Forest Service to approve mine-related actions on BLM-administered lands, and would need to conduct any post-decision administrative review processes required under BLM regulations.
Right-of-Way Application	Bureau of Land Management	In the event Alternative 5 – Peg Leg is selected, Resolution Copper's GPO would be denied with respect to rights-of-way proposed on NFS lands that are identified to be placed on BLM-managed public lands, State lands, or private lands. To use BLM-managed public lands for right-of-way purposes, Resolution Copper would need to obtain surface use authorization from BLM for any right-of-way that crosses BLM-managed public lands.
Project-specific (Individual) Section 404 Clean Water Act Permit	U.S. Army Corps of Engineers	This permit is required for the discharge of dredged or fill material into waters of the U.S. This permit may only be applicable to certain alternatives (see section 1.5.3). Individual Section 404 permits typically incorporate a Habitat Mitigation and Monitoring Plan that details the mitigation that would be implemented to compensate for lost aquatic resources.
Biological Opinion	U.S. Fish and Wildlife Service	The Biological Opinion is issued by the U.S. Fish and Wildlife Service at the completion of consultation under Section 7 of the Endangered Species Act. The Biological Opinion ensures that the Tonto National Forest's approval of the revised mining plan of operations would not jeopardize the continued existence of a threatened or endangered species or adversely modify designated critical habitat. Biological Opinions may authorize "take" of a protected species, and would detail the conservation measures committed to by Resolution Copper, as well as other reasonable and prudent measures (and associated terms and conditions) that must be taken by Resolution Copper. Failure to comply with requirements specified in the Biological Opinion could require reconsultation and could also result in civil and criminal penalties.
Hazardous Waste Identification Number	U.S. Environmental Protection Agency	Authorizes facilities to generate and transport off-site hazardous waste in quantities in excess of 100 kilograms per month (or those that generate acute hazardous waste in quantities exceeding 1 kilogram per month). Requires specific employee training, inspections, and contingency planning.
Radio License	Federal Communications Commission	Required for current use of communication network; would be required during operations.
Hazardous Materials Certificate of Registration	U.S. Department of Transportation	Resolution Copper is certified and would be required to keep certification current during operations as required by the U.S. Department of Transportation hazardous materials program procedures in 49 CFR 107, Subpart G.

continued

Table 1.5.4-1. Permits, licenses, and authorizations required for the Resolution Copper Project *(cont'd)*

Type of Permit	Permitting Agency	Permit Use
Hazardous Materials Transportation Permit	U.S. Department of Transportation	Governs the transport of hazardous materials as defined by the U.S. Department of Transportation. Requires specific employee training and security and contingency planning.
Air Quality Control Permit	Pinal County Air Quality Control District	Resolution Copper currently holds an air quality control permit that pertains to the historical mining (reclamation) and development and exploratory mining exploration facilities operated by Resolution Copper. A similar air quality permit would be required for the full operations. Pinal County Air Quality Control District (PCAQCD) may also issue dust permits for construction, earthwork, and land development. The Skunk Camp alternative may also fall within the jurisdiction of Gila County for air quality permitting. Gila County relies on ADEQ to issue air permits within the county. Consolidating all air permitting under one authority is likely; it has not yet been determined whether this would be PCAQCD or ADEQ.
Meteorological and Ambient Air Monitoring Plan	Pinal County Air Quality Control District	Resolution Copper collects meteorological and air quality monitoring data under a plan approved by PCAQCD. Data collection would continue during operations, but possibly under a separate plan.

assurance is also addressed by regulation: "In determining the amount of the bond, consideration would be given to the estimated cost of stabilizing, rehabilitating, and reclaiming the area of operations" (36 CFR 228.13b).

Reclamation and financial assurance requirements are summarized in Forest Service guidance (U.S. Forest Service 2004), which notes that while in the past long-term maintenance, monitoring, and interim management have not been included in bonding or financial assurance estimates, it is now accepted practice to include these items. The Forest Service guidance notes that: "A basic premise of the estimate is that the operator is not available to complete the reclamation and the Forest Service would need to do the reclamation work" (U.S. Forest Service 2004)However, funding of long-term maintenance and monitoring has always posed a logistical problem, because of the long time frames that would be required. In 2015, the Forest Service issued guidance for establishment of long-term trusts for future large mines, with the intent of eliminating the growing mine-related liabilities on NFS lands (U.S. Forest Service 2015). The guidance allows the Forest Service to accept trust accounts from operators of large mines by establishing a trust with the Forest Service as a benefactor to address long-term liabilities such as water treatment, dam maintenance, and care and maintenance of infrastructure, which may be required for many years (or centuries) beyond a planned or unplanned mine closure. Use of a long-term trust is one method that will be considered to provide fiscal resources to ensure maintenance and monitoring that extend beyond the closure of the mine.

More detail on financial assurances specific to individual resources can be found in Section 3.3, Soils and Vegetation; and Section 3.7.2, Groundwater and Surface Water Quality.

1.6 Public Involvement

The Forest Service sought public input during several phases of the EIS process. A summary of public involvement is outlined in this section.

1.6.1 Scoping

The purpose of the scoping process is to obtain input from agencies and members of the public on the extent of the proposed project, the range of alternatives, and the content of the issue analysis in the EIS. The Forest Service's public participation and public scoping efforts are described in detail in the "Resolution Copper Project and Land Exchange Environmental Impact Statement Scoping Report" (U.S. Forest Service 2017f).

The public scoping period commenced on March 18, 2016, with the Forest Service publication of the Notice of Intent (NOI) to prepare an EIS in the Federal Register. The Forest Service planned for a 60-day public scoping period from March 18, 2016, to May 17, 2016. Numerous individuals and several organizations requested an extension of the public scoping period, as well as additional public scoping meetings. The Forest Supervisor, Tonto National Forest, accommodated these requests by extending the public scoping period through July 18, 2016, resulting in a total overall scoping period of 120 days. The "Notice of Extension of Public Scoping Period for the Resolution Copper Project and Land Exchange EIS" was published in the Federal Register on May 25, 2016.

Tonto National Forest staff held five scoping meetings in the project area that provided the public with an opportunity to ask questions, learn about the proposed project, and provide comments on issues and concerns that should be addressed in the EIS and alternatives that should be valuated (table 1.6.1-1).

Internal scoping efforts included several meetings and field trips with the NEPA interdisciplinary (ID) team. ID team members include Forest Service resource specialists and planners representing anticipated topics of analysis in the NEPA process and Tonto National Forest line officers and program managers.

Cooperating agency scoping was conducted through a kick-off meeting and through comments submitted by cooperating agencies and tribes during the public scoping comment period. Additional detail on scoping conducted during tribal consultation can be found in section 1.6.4.

Table 1.6.1-1. Scoping meeting locations, dates, and attendance numbers

Meeting Location	Date	Number of People Who Signed In
Queen Valley, Arizona – Recreation Hall	March 31, 2016	106
Superior, Arizona – Superior High School	April 4, 2016	78
Globe, Arizona – Globe Elks Lodge	April 5, 2016	63
Gilbert, Arizona – Southeast Regional Library	April 6, 2016	88
San Tan, Arizona – Central Arizona College	June 9, 2016	50

Scoping comment submittals on the Resolution Copper Project and Land Exchange EIS were analyzed and categorized using a standard Forest Service process called "content analysis." The goals of the content analysis process are to (1) ensure that every comment is considered, (2) identify the concerns raised by all respondents, (3) represent the breadth and depth of the public's viewpoints and concerns, and (4) present those concerns in a way that facilitates the Forest Service's consideration of comments. All comments were treated evenly and were not weighted by number, organizational affiliation, "status" of the commenter, or other factors. Consideration was on the content of a comment, rather than on who wrote it or the number of submitters who agreed with it.

In total, 133,653 submittals were collected during public scoping, 141 of which were identified as duplicate submittals. Of the non-duplicate submittals received, 131,592 submittals or 98.56 percent were identified as form letters, 683 submittals or 0.51 percent as form letters with additional comments, and 1,237 or 0.94 percent as unique submittals. Approximately 99.89 percent of submittals were from individuals, with

the remaining submittals from non-governmental organizations (NGOs), and governments (table 1.6.1-2).

The contents of the comments received during scoping are summarized in the project record.[7] The scoping comments were used to develop the issues (see Section 1.7, Issues), alternatives (see Chapter 2, Alternatives, Including the Proposed Action), and mitigation strategies that form the EIS analysis.

Table 1.6.1-2. Distribution of submittals by sender type

Sender Type	Submittal Count
Individual	133,368
NGO	66
Government	78
Total	**133,512**

1.6.2 Project Update and Alternatives Development Workshop

As part of the EIS process, the Forest Service is required to investigate alternatives to various aspects of the proposed action described in section 2.2.4. During the alternatives development process,[8] the Forest Service hosted two in-person public workshops and one online workshop to (1) update the public on the status of the EIS process, (2) describe the alternatives development process, and (3) solicit input on the criteria being used to evaluate alternative tailings storage facility locations. The in-person workshops were held in Superior, Arizona, on March 21, 2017, and in Gilbert, Arizona, on March 22, 2017. The online workshop was available on the project website from March 23, 2017, through April 5, 2017. Workshop attendees were asked to provide input regarding the relative importance of a variety of environmental and social criteria regarding the location of the tailings storage facility. The public responses showed Environmental Impacts and Tailings Storage Location as their primary concern, with protection of streams and springs having the highest concern. The Forest Service used the information gathered to inform the evaluation and comparison of alternative tailings storage facility locations during the alternatives development process.

1.6.3 Cooperating Agencies

The Council on Environmental Quality (CEQ) regulations (40 CFR 1508.5) define a cooperating agency as any Federal agency (other than the lead agency) and any State or local agency or Indian Tribe with jurisdictional authority or special expertise with respect to any environmental impact involved in a proposal. Nine cooperating agencies with jurisdictional authority and/or applicable special expertise cooperated in the development of this EIS (table 1.6.3-1).

The cooperating agencies assisted with EIS preparation in a number of ways, including providing research and baseline data information, reviewing scientific reports, identifying issues, assisting with the formulation of alternatives, and reviewing preliminary DEIS content and other EIS materials.

1.6.4 Tribal Consultation

Federal agencies consult on a government-to-government basis with federally recognized Native American tribes having traditional interests in and/or ties to the lands potentially affected by a proposed action and alternatives. The Forest Service is conducting ongoing consultation with 15 tribes, in accordance with the NDAA and the Forest Service Handbook (FSH) Section 1509.13, Chapter 10, "Consultation with

7. See "Resolution Copper Project and Land Exchange Environmental Impact Statement Scoping Report" (U.S. Forest Service 2017f); "Resolution Copper Project and Land Exchange Environmental Impact Statement Public Concern Statements" (U.S. Forest Service 2017e); "Resolution Copper Project and Land Exchange Environmental Impact Statement Final Summary of Issues Identified Through Scoping Process" (SWCA Environmental Consultants 2017b).

8. See "Resolution Copper Project and Land Exchange Environmental Impact Statement Alternatives Evaluation Report" (SWCA Environmental Consultants 2017a).

Table 1.6.3-1. Cooperating agencies participating in the EIS process

Agency	Resource Area of Expertise
Arizona Department of Environmental Quality	Special expertise and jurisdiction under the authority of Arizona Revised Statutes (ARS) Title 49, having jurisdiction to manage environmental resources within the state of Arizona, including protection of air and water resources; aquifer protection; drinking water protection; solid and hazardous waste generation and control; and environmental economics and policy.
Arizona Department of Water Resources	Special expertise in water resources and ensuring technical accuracy and conformance with laws, regulations, and policies within the Arizona Department of Water Resources' special expertise.
Arizona Game and Fish Department	Jurisdiction over wildlife in the state of Arizona. Special expertise with wildlife including endangered, threatened, and special status species, recommendations for mitigation, and assistance with data evaluation and review relative to the department's State Trust responsibilities and jurisdiction.
Arizona State Land Department	Jurisdictional responsibilities and special expertise in matters related to management of, and potential impacts on, State Trust land.
Arizona State Mine Inspector	Jurisdictional responsibilities and special expertise in matters related to protecting the lives, health, and safety of miners and the health and safety of the general public. The Arizona State Mine Inspector is also responsible for oversight of mine closure and reclamation on State and private lands.
Bureau of Land Management	Jurisdiction over lands managed by BLM or parcels that would transfer to BLM ownership. BLM would review the land exchange proposal under 43 CFR 2200. BLM may review and decide on a request for surface use authorization from Resolution Copper, if one is ultimately submitted under the applicable BLM regulations.
Pinal County Air Quality Control Division	Special expertise and jurisdiction to regulate air-polluting activities identified in the Pinal County Air Pollution Control District Code of Regulations and further identified in ARS Title 49, Article 3.
U.S. Army Corps of Engineers	Special expertise pertains to protection of waters of the U.S., and preservation of USACE-constructed public works. *Would assist with NEPA review only at this time; if waters of the U.S. would be affected, then the agency would have regulatory jurisdiction under CWA regulations.*
U.S. Environmental Protection Agency	Jurisdiction over a number of Federal environmental laws, including the Clean Air Act, the Clean Water Act, and the Safe Drinking Water Act. The U.S. Environmental Protection Agency (EPA) reviews and comments on EISs pursuant to its authority under NEPA, 42 U.S.C. 4371 et seq., Clean Air Act Section 309, 42 U.S.C. 7609, and pursuant to CEQ's "Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act" at 40 CFR 1500–1508. EPA's participation in this EIS does not imply endorsement of the project or preferred alternative and does not abridge the independent review of the EIS, which EPA conducts pursuant to NEPA and Section 309 of the Clean Air Act, 42 U.S.C. 7609.
Arizona State Parks (Arizona State Historic Preservation Office)	Declined status as a cooperating agency; however, they have a consulting role under Section 106 of the NHPA.

Indian Tribes and Alaska Native Corporations" (U.S. Forest Service 2016b). Content discussed in government-to-government consultations is confidentially protected under Subtitle B, "Cultural and Heritage Cooperation Authority," Sections 8101–8107(5) of Public Law (PL) 110–234, which authorizes the Secretary of Agriculture to protect the confidentiality of certain information, including information that is culturally sensitive to Indian Tribes.

Government-to-government consultation for this land exchange process and EIS process was initiated with a formal letter from Forest Supervisor Neil Bosworth to tribes in August 2015 and April 2016. The Forest Service held meetings and continues to seek tribal input via written correspondence, telephone calls, and in-person meetings. Details of the government-to-government consultation process are summarized in Chapter 4, Consulted Parties.

1.7 Issues

Issues serve to highlight effects or unintended consequences that may occur from the proposed action and alternatives, giving opportunities during the analysis to reduce adverse effects and compare trade-offs. Issues help set the scope of the actions, alternatives, and effects to consider in our analysis (FSH 1909.15.12.4) (U.S. Forest Service 2012a).

Comments submitted during the scoping period were used to formulate issues concerning the proposed action. Issues are statements of cause and effect, linking environmental effects to actions (FSH 1909.15.12.41) (U.S. Forest Service 2012a). The EIS ID team separated the issues into two groups: significant and non-significant. Significant issues were defined as those directly or indirectly caused by implementing the proposed action. Non-significant issues as identified by CEQ regulations include issues that are outside the scope of the proposed action; already decided by law, regulation, forest plan, or other higher level decision; irrelevant to the decision to be made; or conjectural and not supported by scientific or factual evidence.

The CEQ NEPA regulations state that the EIS should "identify and eliminate from detailed study the issues which are not significant, or which have been covered by prior environmental review (Sec. 1506.3)." A list of non-significant issues and reasons regarding their categorization as non-significant may be found in the project record.[9]

While completing the EIS analysis, some factors and issues formulated during scoping were modified to accurately analyze the resource impacts. Appendix E, Table E-1, Alternatives Impact Summary, documents the issues and issue factors used or modified during the EIS analysis.

The following issue summaries represent brief synopses of the 14 major project issues that were developed from input provided by agencies, tribes, stakeholders, and the public during scoping for this EIS. Many of the identified primary issues were then subdivided into detailed sub-issues in an effort to more fully and accurately capture the c=oncerns expressed. The complete listing of primary issues and sub-issues is included in Appendix E, Table E-1, Alternatives Impact Summary, as well as in the "Resolution Copper Project and Land Exchange Environmental Impact Statement: Final Summary of Issues Identified Through Scoping Process" (Issues Report), available at https://www.resolutionmineeis.us/documents/usfs-tonto-issues-report-201711.

1.7.1 Issue 1 – Tribal Values and Concerns

Tribes are concerned about current and future adverse effects on area resources from the Resolution Copper Project, as well as other ongoing mining, transportation, energy transmission, pipeline, and other developments in and around the Superior region. These affected resources may include physical resources such as access routes, air, groundwater and surface water, plant and animal life, and landscapes, as well as less tangible attributes such as sense of place; sense of historical,

9. See "Resolution Copper Project and Land Exchange Environmental Impact Statement FINAL Summary of Issues Identified Through Scoping Process" (U.S. Forest Service 2017f).

spiritual, and tribal identity; opportunities for solitude; and opportunities to continue traditional cultural practices and ceremonies.

1.7.2 Issue 2 – Socioeconomics

Construction and operation of the Resolution Copper Project would result in substantial economic and "quality of life" changes—both beneficial and adverse—in the greater Superior area. A large influx of workers to the area would lead to greater demands for housing and capacity pressures on local schools, hospitals, and other medical service providers, as well as on municipal infrastructure such as roads, water and sewer systems, and electrical and communications systems. Conversely, this same influx of workers would contribute to greater retail spending on goods and consumer services in the area and to increased tax revenues to local, county, and state governments. Residential and commercial property values may increase for some but decline for those whose properties are considered negatively affected by proximity to mine facilities (such as the tailings storage area). Some qualities of rural life may be diminished through increased traffic and a possible decrease in local recreational opportunities.

1.7.3 Issue 3 – Environmental Justice

Economic benefits may not be experienced by all sectors of society equally; historically, minority and low-income communities (including tribal communities) in a given area tend to accrue less benefit from large-scale land development and mining projects than the population of the area as a whole. In addition, it is possible that minority and low-income communities may be disproportionately affected by adverse environmental effects, potentially including greater risks to human health and safety.

1.7.4 Issue 4 – Cultural Resources

Construction and operation of the mine would profoundly and permanently alter the National Register of Historic Places (NRHP)-listed *Chí'chil Biłdagoteel* (Oak Flat) Historic District Traditional Cultural Property (TCP) through anticipated large-scale geological subsidence. Linear facilities, including new pipelines, power lines, and roads, as well as other facilities such as electrical substations, would also be constructed in support of mine operations. In addition, development of the proposed tailings storage facility at any of the four proposed or alternative locations would permanently bury or otherwise destroy many prehistoric and historic cultural artifacts, potentially including human burials. Disturbance of known or unknown cultural resources is an impact that is important to many tribes, regardless of whether data recovery is undertaken.

1.7.5 Issue 5 – Public Health and Safety

Construction and ongoing operation of the mine may have a variety of adverse effects on public health and safety. These concerns have focused principally on possible risks of breach or other failure of the tailings facility embankment; emissions and negative effects on air quality; possible seepage from or other contamination related to the tailings facility fouling local groundwater supplies; the potential for hazardous material/chemical spills; conflicts between mine-related haul truck and employee vehicles and residential traffic (including pedestrians); possible safety issues resulting from the anticipated subsidence in the Oak Flat area; and potentially increased risk of wildfire from mine operations.

1.7.6 Issue 6 – Water Resources

Potential effects on groundwater and surface water resources from construction, operation, closure, and reclamation of the Resolution Copper Mine is a multi-faceted and complex issue. In many ways, groundwater and surface waters are interconnected, and depletions and geochemical or other alterations of one are likely to affect the other, as well as to affect water-dependent resources such as vegetation and wildlife.

This issue is further complicated by the highly complex geological setting in which the Resolution Copper Mine would be constructed,

which would be permanently altered by large-scale ore removal and geological subsidence. The resulting 7,000-foot-deep area of fractured rock and approximately 1.8-mile-wide subsidence crater at the surface of Oak Flat, together with ongoing mine dewatering, would be likely over time to result in measurable reductions in flows in Devil's Canyon and Queen Creek and the long-term loss of some seeps and springs in the Superior area.

In addition, a tailings storage facility at either the proposed (Near West) location or at any of the three alternative sites (Silver King, Peg Leg, and Skunk Camp) would, through necessary stormwater management and seepage control practices, reduce the amount of surface water available in that particular watershed. The tailings storage facility also presents risks to the watershed through the potential for contaminants from metals or chemicals in tailings seepage to escape controls and enter groundwater and/or downstream surface waters, thereby potentially threatening riparian areas and other wildlife habitats, human uses, and waters provided to livestock.

1.7.7 Issue 7 – Biological Resources

Mine development has the potential to adversely affect local flora and fauna, including through direct injury or mortality; habitat alteration and loss; habitat fragmentation; reduction in water available to the ecosystem; disturbance by vehicular traffic, increased noise, and increased light; potential exposure to toxic chemicals or other hazardous substances; introduction and/or propagation of noxious or invasive plant species; and curtailed reproduction, pollination, seed dispersal, and other biological processes.

1.7.8 Issue 8 – Air Quality

Construction, ongoing ore recovery and processing, and other related activities at the mine and along transportation and utility corridors would increase dust, airborne chemicals, and transportation-related (mobile) emissions in the area, which has the potential to result in exceedances of one or more established air quality standards.

1.7.9 Issue 9 – Long-term Land Suitability

The mining proposed in the GPO is expected to cause large-scale surface subsidence in the Oak Flat area, eventually resulting in a subsidence crater up to 1.8 miles in diameter at the surface and between 800 and 1,115 feet deep. In addition, mine-related ground disturbance from clearing vegetation, grading, and stockpiling soils or equipment or other materials has the potential to compact soils, accelerate erosion, and reduce soil productivity. Damage, disturbance, contamination, or removal of soil may result in a long-term loss of soil productivity, physical structure, and ecological function across the proposed mine site as well as on lands downgradient of mine facilities.

1.7.10 Issue 10 – Recreation

Mine development in the Oak Flat area, including within the anticipated subsidence area and, ultimately, at Oak Flat Campground, would eliminate numerous recreational opportunities in this part of the Tonto National Forest. Much of the area would be fenced off and no longer accessible to hikers, rock climbing enthusiasts, cyclists, equestrians, campers, hunters, and other recreational users of these former public lands.

Mine-related linear facilities such as pipelines, power lines, and development within the MARRCO corridor may also sever connectivity of existing roads and trails and further limit recreational access. In addition, construction of a large tailings storage facility somewhere in the greater Superior area is now being evaluated in ongoing environmental and technical studies; ultimately, this facility may be located on either NFS, BLM, or private lands. Wherever constructed, the area of such a facility would be closed to all recreational uses, resulting in displacement of existing recreation in that area to other locations.

1.7.11 Issue 11 – Scenic Resources

Construction and operation of the Resolution Copper Mine would, as a result of anticipated geological subsidence at the East Plant Site, permanently alter the topography and scenic character of the Oak Flat

area. Development of a proposed tailings storage facility at any of the four alternative locations now being considered would ultimately result in a new and permanent landform approximately 3,200 to 5,800 acres in area (depending on the alternative) and several hundred feet higher than the current landscape, thus forever altering the existing viewsheds. New utility lines and construction of other mine facilities and infrastructure at the West Plant Site, East Plant Site, and filter plant and loadout facility would alter existing viewsheds, although some of these facilities may be removed and the associated areas reclaimed following mine closure.

1.7.12 Issue 12 – Transportation and Access

Transportation of personnel, equipment, supplies, and materials related to mine development, operation, and reclamation would increase traffic in and around the town of Superior. Increased mine-related traffic on local roads and highways has the potential to impact local and regional traffic patterns, levels of service, and planned transportation projects and users of NFS roads. Increased mine-associated rail traffic along the MARRCO corridor also has the potential to impact traffic patterns in the local area.

Mine development is likely to result in permanently altered, added, or decommissioned NFS roads or to temporarily restrict access to NFS roads and lands, which could impact recreational users, visitors, and permittees.

1.7.13 Issue 13 – Noise and Vibration

Development, operation, and reclamation of the mine would result in an increase in noise and vibration in the immediate vicinity of mine facilities. Activities that could increase noise and vibration include blasting, underground conveyance of ore, processing operations, operations at the filter plant and loadout facility, and, in the Oak Flat area, episodic land subsidence events. Increases in traffic associated with worker commuting, material delivery, and mine product shipment could also contribute to an overall increase in noise and vibration on area roads and highways.

1.7.14 Issue 14 – Land Ownership and Boundary Management

Changes in land ownership could have impacts as a result of the loss of public lands from the land exchange and mine proposal, including impacts on recreational access and to ranching in the area resulting from changes in easements, rights-of-way, fencing, and/or livestock access, or through special land or resource conservation agreements. Effects on current boundary management of Federal, State, and private lands in the area may include removal or other loss of survey markers, corner monuments, fences, and similar features, particularly in the area of the proposed or alternative tailings storage facility locations.

1.8 Other Proponent-Related Activities on National Forest System Lands

The Tonto National Forest has reviewed and approved multiple other analyses and NEPA documents completed in support of the project. A list of additional projects that have been analyzed can be found in table 1.4-1 of the GPO.

1.8.1 Plan of Operations for Baseline Hydrological and Geotechnical Data-Gathering Activities

Several plans of operation for the copper deposit have been processed during the exploration and development phases to authorize surface-disturbing activities. Currently, Resolution Copper is conducting development drilling in accordance with the approved "Pre-feasibility Plan of Operations," which was authorized in 2010 (U.S. Forest Service 2010c).

In 2013, Resolution Copper submitted the proposed "Plan of Operations for Baseline Hydrological and Geotechnical Data Gathering Activities" (Resolution Copper 2016e). The purpose of this proposal was to collect hydrological, geochemical, and geotechnical data at the location of

a potential tailings storage site. The hydrologic, geochemical, and geotechnical data are being used to support detailed design of the facility and the environmental analysis contained in this EIS.

Baseline activities affected approximately 75 acres located on public lands managed by the Tonto National Forest approximately 4.5 miles west of Superior, Arizona. Activities included construction of temporary access roads and drilling/trenching sites; improvement of existing access roads; and installation of groundwater monitoring wells, geotechnical bore holes, and trenches.

1.8.2 Apache Leap Special Management Area

The Carl Levin and Howard P. 'Buck' McKeon National Defense Authorization Act for Fiscal Year 2015 (NDAA) (Section 3003(g)) designated Apache Leap a special management area for the purpose of preserving the natural character of Apache Leap, allowing traditional uses by Indian Tribes, and protecting and conserving the cultural and archaeological resources of the area. The Forest Service designated the 839-acre Apache Leap Special Management Area (SMA) and developed a management plan to adopt long-range direction for managing natural and cultural resources and human uses of the area (pursuant to terms set forth in the NDAA).

In December 2017, the Tonto National Forest finalized the environmental review process and the management plan. The plan establishes a comprehensive framework for managing the Apache Leap SMA, with an emphasis on the preservation of the three primary purposes outlined in the previous paragraph.

The forest plan was amended on December 26, 2017, to include the Apache Leap SMA as a designated management area and to incorporate plan components specific to the Apache Leap SMA that follow NFS land management planning regulations adopted in 2012.

As related to the Resolution Copper Project and Land Exchange, the NDAA Section 3003(g)(4)(B) specifically authorized the following activities in the Apache Leap SMA:

- installation of seismic monitoring equipment on the surface and subsurface to protect the resources located within the special management area;
- installation of fences, signs, or other measures necessary to protect the health and safety of the public; and
- operation of an underground tunnel and associated workings, as described in the GPO, subject to any terms and conditions the Secretary of Agriculture may reasonably require.

Overview

The Forest Service developed reasonable and feasible alternatives to the proposed action to resolve, minimize, or reduce impacts on people and resources by identified issues while meeting the purpose of and need for the proposed action.

Alternatives are a mix of strategies that meet the purpose of and need for the proposed action and resolve or address key issues identified during scoping.

Alternatives for this EIS include the proposed action and no action alternative, along with a range of reasonable action alternatives.

Alternatives, Including the Proposed Action

2.1 Introduction

Council on Environmental Quality regulations describe the alternatives section as the "heart of the Environmental Impact Statement," and require Federal agencies to "rigorously explore and objectively evaluate all reasonable alternatives and for alternatives which were eliminated from detailed study, briefly discuss the reasons for their having been eliminated" (40 CFR 1502.14).

Chapter 2 summarizes the alternatives development process, summarizes alternatives eliminated from further consideration, and describes the alternatives carried forward for detailed analysis in the EIS. This chapter presents the range of alternatives in comparative form, sharply defining the differences between each alternative and providing a clear basis for comparison and choice among options by the decision maker and the public. The differences between alternatives include changes in the location, design, or engineering of the alternative (e.g., acreage required for the footprint of each tailings storage facility); these are discussed in section 2.2. Other differences between alternatives are based on the environmental effects (e.g., the amount of dust caused by different tailings processing methods), social effects (e.g., the miles of roads used for recreation that are lost), and economic effects (e.g., the reduction in property values near the tailings storage facility) of implementing each alternative. Section 2.5 and appendix E include a summary of these effects; chapter 3 provides a more detailed analysis of these effects.

The alternatives development process included comments provided during the scoping period for alternatives that should be considered in the EIS. Alternatives consist of a mix of strategies that meet the purpose of and need for the proposed action and resolve or address key issues identified during scoping. The additional alternatives that were determined to be outside the scope of the project, duplicative of the alternatives already being considered in detail, or technically or economically infeasible or that were determined to include components that would cause unnecessary environmental harm, are further described in Appendix F, Alternatives Considered but Dismissed from Detailed Analysis.

Alternatives considered but dismissed from detailed analysis in this EIS include the following:

- Alternative mining techniques,
- Brownfield tailings disposal, and
- Other alternative tailings disposal locations.

The Forest Service developed the following six alternatives for analysis in the EIS, which include the no action and proposed action alternatives, in response to issues raised by the public, the Tonto National Forest, or cooperating agencies (see section 1.7).

For reference in reviewing this chapter and the EIS in general, a comprehensive glossary of technical mining terminology is included in chapter 7.

2.2 Alternatives Considered in Detail

- Alternative 1 – No Action Alternative. The land exchange would not occur, and the GPO would not be approved. Existing activities occurring on private land would continue as permitted (see section 2.2.3).
- Alternative 2 – Near West Proposed Action. This alternative is a variation of the proposed action described in the May 9, 2016, version of the GPO. Alternative 2 would include a split-stream tailings processing method with two tailings types deposited at a facility at the "Near West" location with a modified centerline embankment (see section 2.2.4).
- Alternative 3 – Near West – Ultrathickened. Alternative 3 proposes to reduce the amount of water retained in the non-potentially acid generating (NPAG)[10] tailings as well as reduce seepage potential through on-site ultrathickening of NPAG tailings at a facility at the "Near West" location with a modified centerline embankment (see section 2.2.5).
- Alternative 4 – Silver King. This is the only alternative that proposes to use filtered tailings instead of slurry tailings at a facility located north of Superior and the West Plant Site. After filtering, conveyors and mobile equipment would mechanically deposit potentially acid generating (PAG)[11] and NPAG tailings in two separate, adjacent storage facilities (see section 2.2.6).
- Alternative 5 – Peg Leg. This alternative allows for a comparison of the impacts of slurry tailings if placed in a flatter alluvial setting instead of in an upland wash or canyon. The tailings would be placed behind a centerline embankment at a location approximately 20 miles south of Superior. Two different corridors for tailings transportation are under consideration (see section 2.2.7).
- **Alternative 6 – Skunk Camp (Lead Agency Preferred).** This alternative uses a centerline, cross-valley embankment at a location approximately 20 miles southeast of Superior. This location requires less fill material to retain tailings, compared with a ring-like impoundment, simplifying construction and operations. Two different corridors for tailings transportation are under consideration (see section 2.2.8).

The tailings storage facility and type of tailings processing and placement formed the most substantial differences between alternatives, as shown in table 2.2-1.

2.2.1 Forest Service Preferred Alternative

The Forest Service has identified Alternative 6 – Skunk Camp North Tailings Corridor Option as the Lead Agency's preferred alternative and seeks public feedback during the 90-day comment period for the DEIS regarding this choice.

2.2.2 Elements Common to All Action Alternatives

Elements that are common to the proposed action and action alternatives are described in this section. Later sections in chapter 2 describe specific features or changes that are particular to each individual alternative. The elements that are common to all alternatives include the land exchange process, a GPO, and amendments to the Forest Plan (see section 1.4.3).

2.2.2.1 Land Exchange

Section 3003 of the NDAA authorizes and directs the Secretary of Agriculture to administer a land exchange between Resolution Copper and the Forest Service. The NDAA also directs the Forest Service

10. *Scavenger* is another term found in reference documents and is synonymous with NPAG.

11. *Pyrite* and *cleaner* are other terms found in reference documents and are synonymous with PAG.

Table 2.2-1. Tailings storage facility comparison

Alternative	Tailings Storage Facility and Tailings Corridor (acres)	Embankment Length and Type	Separate PAG Cell?	Distance for Tailings Slurry (miles)	Tailings Type	Total Groundwater Pumped from Desert Wellfield (acre-feet)
Alternative 2 – Near West Proposed Action	4,981	10-mile-long modified centerline embankment	Not separated	5.3	Thickened slurry (NPAG and PAG)	600,000
Alternative 3 – Near West –Ultrathickened	4,981	10-mile-long modified centerline embankment	Separate cell using an internal splitter berm	5.3	Ultrathickened NPAG slurry; thickened PAG slurry	500,000
Alternative 4 – Silver King	5,691	Not applicable – compacted structural zone	Separated, 1 cell	0.2	Filtered	180,000
Alternative 5 – Peg Leg West Tailings Corridor Option	12,455	7-mile-long centerline embankment	Separated, 4 cells	28.1	Thickened slurry (NPAG and PAG)	550,000
Alternative 5 – Peg Leg East Tailings Corridor Option	12,122	7-mile-long centerline embankment	Separated, 4 cells	22.7	Thickened slurry (NPAG and PAG)	550,000
Alternative 6 – Skunk Camp North Tailings Corridor Option	10,112	3-mile-long centerline embankment	Separated, 2 cells	19.8	Thickened slurry (NPAG and PAG)	550,000
Alternative 6 – Skunk Camp South Tailings Corridor Option	10,591	3-mile-long centerline embankment	Separated, 2 cells	25.2	Thickened slurry (NPAG and PAG)	550,000

to carry out the land exchange in accordance with the requirements of NEPA with a single EIS. The land exchange is not a discretional decision, but required by the NDAA; therefore, no decision will be issued for the land exchange process. As detailed in the NDAA, the land exchange would convey 2,422 acres of NFS land (selected lands) to Resolution Copper. The land being transferred to Resolution Copper is located east of the town of Superior in an area known as Oak Flat.

In exchange for the transfer of the Oak Flat Federal Parcel out of Federal ownership, Resolution Copper would convey private land parcels to the Federal Government consisting of approximately 5,376 acres of private land (offered lands) on eight parcels located elsewhere in Arizona.

The selected and offered land exchange parcels are listed in the legislation authorizing the land exchange (figure 2.2.2-1 and Appendix B, Existing Conditions of Offered Lands). See table 1.4.2-1 in chapter 1 for a summary of the land exchange components. Detailed figures for each of the land exchange parcels are provided in Appendix B.

Selected Lands

The selected lands include 2,422 acres of NFS lands, known as the Oak Flat Federal Parcel, located east of Superior in Pinal County, Arizona. The lands transferred from the NFS to Resolution Copper would become private lands (both surface and subsurface mineral estate).

The Oak Flat Withdrawal Area includes a 50-acre campground with 16 campsites, known as the Oak Flat Campground. The Oak Flat Campground would be conveyed to Resolution Copper during the land exchange. As a condition of conveyance of the Federal land, Resolution Copper must agree to provide access to the surface of Oak Flat Campground to members of the public until such a time that mine operations preclude access for safety reasons.

The Oak Flat Federal Parcel is adjacent to and surrounding Resolution Copper private land on which the existing East Plant Site mining facilities are located. The underground mining operations would take place beneath the Oak Flat Federal Parcel, and additional infrastructure would be located on the Oak Flat Federal Parcel after approval of the final GPO and execution of the land exchange.

Offered Lands

The offered lands include approximately 5,376 acres of Resolution Copper private land on eight parcel groups located throughout Arizona. The parcels of offered lands would be transferred to the United States, for administration by either the Forest Service or BLM.

FOREST SERVICE

Land exchange parcel locations are shown in figure 2.2.2-1. Five of the eight parcels Resolution Copper would transfer to the Federal Government would administratively fall under the Forest Service.

Apache Leap South End Parcel. The Apache Leap South End Parcel consists of 142 acres located near the eastern edge of the town of Superior in Pinal County, Arizona. The Apache Leap South End Parcel would become part of the Apache Leap SMA, administered by the Tonto National Forest, Globe Ranger District. Upon completion of the land exchange, Resolution Copper would surrender all mining claims and interests to this parcel.

The parcel includes lands located above and below Apache Leap, an escarpment of sheer cliff faces, hoodoos, and buttresses that forms the scenic backdrop to the town of Superior. Vegetation on the parcel includes shrubs, cacti, and trees such as mesquite, paloverde, and ironwood below the escarpment and woody evergreens and shrubs such as oaks above the escarpment. Current land uses on the parcel include informal recreation and livestock grazing. Additionally, there are multiple historic mining features and remnants of old mining-related roads located throughout the parcel. The acreage of this parcel was updated based on a cadastral survey completed by the BLM in 2018.

Tangle Creek Parcel. Located in Yavapai County, Arizona, approximately 35 miles north of the towns of Cave Creek and Carefree, the Tangle Creek Parcel is a 148-acre private inholding within the Tonto

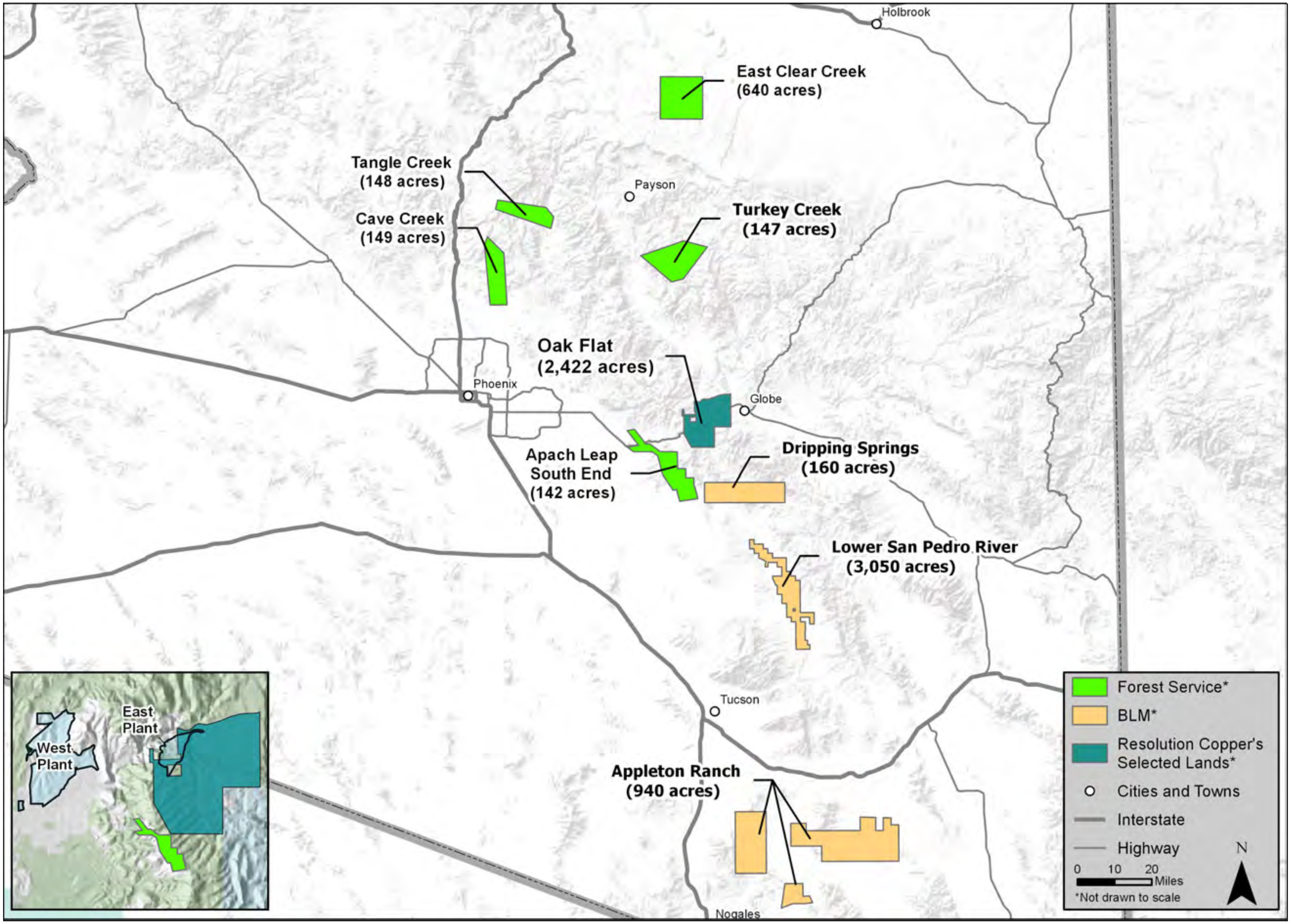


Figure 2.2.2-1. Land exchange parcels overview

National Forest. The parcel would be administered by the Tonto National Forest, Cave Creek Ranger District.

The Tangle Creek Parcel is located in Bloody Basin, a rugged and scenic basin in central Arizona with abundant hiking, camping, and hunting opportunities. The parcel was homesteaded in the 1890s by the Babbitt family. The historically cultivated farm fields are in the process of reverting to open woodlands and thickets of hackberry, mesquite, and catclaw acacia. Features of the Tangle Creek Parcel include Tangle Creek (an intermittent stream) and associated riparian habitat, as well as mature netleaf hackberry, mesquite, ash, and sycamore trees, which provide habitat for migratory birds and nesting songbirds. The parcel also contains a power line transmission corridor.

Turkey Creek Parcel. The Turkey Creek Parcel is a 147-acre parcel located approximately 8 miles southeast of the community of Pleasant Valley in Gila County, Arizona. The Turkey Creek Parcel is a private inholding within the Tonto National Forest and would be administered by the Tonto National Forest, Pleasant Valley Ranger District.

The parcel includes a historic 1880s-era homestead, including the cabin site foundation, hand-dug well, and fruit trees. Turkey Creek (an intermittent stream) and associated riparian habitat also provide varied wildlife habitat for elk, mule deer, and native fish and proposed critical habitat and two protected activity centers for Mexican spotted owl.[12]

Cave Creek Parcel. The Cave Creek Parcel is a 149-acre parcel located approximately 7 miles north of Cave Creek in Maricopa County, Arizona. The Cave Creek Parcel is a private inholding surrounded by Tonto National Forest lands. Upon completion of the land exchange, the parcel would be administered by the Tonto National Forest, Cave Creek Ranger District.

The Cave Creek Parcel includes Cave Creek (an intermittent stream) and its riparian habitat corridor, with stands of cottonwood and mesquite trees. Perennial waters provide wildlife habitat for migratory songbirds, raptors, amphibians, javelina, mule deer, and coyotes. The parcel also encompasses numerous archaeological sites, including petroglyphs, structure ruins, and grinding sites.

East Clear Creek Parcel. The East Clear Creek Parcel is a 640-acre private inholding within the Coconino National Forest, located north of Payson in Coconino County, Arizona. The parcel would be administered by the Coconino National Forest, Mogollon Rim Ranger District. The East Clear Creek Parcel is located in a transitional zone between the upper plateau and riparian ecosystems on the Mogollon Rim. The parcel includes portions of East Clear Creek Canyon and several secondary side canyons, which provide riparian wildlife habitat and raptor nesting and roosting sites.[13] East Clear Creek is a perennial stream.

BUREAU OF LAND MANAGEMENT

The BLM would administer the remaining three parcels of land to be transferred from Resolution Copper to the Federal Government.

Lower San Pedro River Parcel. The Lower San Pedro River Parcel is approximately 3,050-acre parcel located near Mammoth in Pinal County, Arizona. In November 1988, Congress designated 40 miles and approximately 56,000 acres of the upper San Pedro corridor as the San Pedro Riparian National Conservation Area. The parcel, which includes approximately 7 miles of the Lower San Pedro River (an intermittent stream at this location), would be administered by the BLM Gila District, Tucson Field Office, as part of the San Pedro Riparian National Conservation Area. The parcel is non-contiguous to, and roughly 60 miles northwest of, the existing BLM-administered San Pedro Riparian National Conservation Area. The riparian corridor in the parcel includes more than 800 acres of mesquite woodland that features a spring-fed wetland. The parcel's riparian areas and woodlands provide habitat for a wide variety of wildlife, including many migratory bird species and

12. The Bear Fire (July 2018) had minimal burn effects on the Turkey Creek Parcel.

13. The Tinder Fire (April 2018) did burn a large portion of the East Clear Creek Parcel, with vegetation burned from grass through crown level.

lowland leopard frogs. This parcel acreage is approximate and would be updated after BLM completes a cadastral survey in 2019.

Appleton Ranch Parcel. The Appleton Ranch Parcel includes approximately 940 acres of non-contiguous private lands south of Elgin in Santa Cruz County, Arizona. The parcels are within the Appleton-Whittell Research Ranch and Las Cienegas National Conservation Area acquisition area. The parcels are to be administered by the BLM Gila District, Tucson Field Office, as part of the Las Cienegas National Conservation Area. The Las Cienegas National Conservation Area, established in 2000, is a 45,000-acre conservation area containing cottonwood-willow riparian forests and marshlands associated with Cienega Creek, rolling grasslands, and woodlands. The Appleton-Whittell Research Ranch was established in 1969 by the Appleton family in partnership with the National Audubon Society, Forest Service, and BLM as a sanctuary for native plants and animals and a research facility for the study of grassland ecosystems. The ranch, currently managed by the National Audubon Society, contains more than 90 species of native grass and 480 native plant species and is used by more than 200 species of birds for wintering, breeding, or migratory habitat. This parcel acreage is approximate and will be updated after BLM completes a cadastral survey in 2019.

Dripping Springs Parcel. The Dripping Springs Parcel is a 160-acre parcel located northeast of Kearny in Gila and Pinal Counties, Arizona. The parcel, situated in the Dripping Spring Mountains near Tam O'Shanter Peak, is almost completely surrounded by BLM-administered lands, with some adjacent ASLD-administered State Trust land. The parcel would be administered by the BLM Gila District, Tucson Field Office. Vegetation on the parcel includes shrubs, cacti, and desert trees such as paloverde, ironwood, and mesquite, as well as areas of semidesert grassland with desert grasses and shrubs. The parcel's abundant rock formations are known for offering recreational rock-climbing opportunities.

Land Exchange Appraisal

NDAA Section 3003(c)(5) requires that the private lands to be exchanged also be of equal monetary value to the Federal lands; however, the NDAA specifically waives the Federal Land Policy and Management Act (FLPMA)-mandated 25 percent cap, allowing a larger percentage of cash payment on the differences in exchange values, if any exist, for the Resolution Copper project. This allows the Secretary of Agriculture to accept a payment in excess of the FLPMA-mandated 25 percent cap in order to achieve a parity in overall exchange values.

APPRAISAL PROCESS

The appraisal will use the Uniform Standards of Professional Appraisal Practice, the Uniform Appraisal Standards for Federal Land Acquisitions, and Federal regulations under 36 CFR 254.9 (Forest Service appraisal procedures). The Uniform Standards of Professional Appraisal Practice are the industry standard for real estate appraisals. The Uniform Appraisal Standards for Federal Land Acquisitions are an additional set of appraisal standards for Federal land acquisitions and exchanges. The appraisal process began with the Notice of Exchange Proposal Land-For-Land Exchange published on December 12, 2017.

The NDAA requires the joint selection of a qualified appraiser by both parties (the Federal Government and Resolution Copper). The appraiser was selected and began work in 2019. The completed appraisal reports will be reviewed by a Forest Service review appraiser. The review appraiser will ensure that the appraisal follows the appraisal instructions, Uniform Standards of Professional Appraisal Practice and Uniform Appraisal Standards for Federal Land Acquisitions standards, Federal regulations, and the special requirements found in the NDAA. The review appraiser will ensure that the values concluded by the appraiser are sound and well supported.

The NDAA specifies "a detailed income capitalization approach analysis of the market value of the Federal land which may be utilized, as appropriate, to determine the value of the Federal land." The income

capitalization approach is one of three commonly used approaches used for real property appraisals.

The NDAA specifies that the appraisal reports (or a summary thereof) supporting the land exchange will be made available for public review prior to completion of the land exchange. The appraisal information will be made available after it is reviewed and approved by the Forest Service review appraiser.

2.2.2.2 General Plan of Operations Components

The proposed action consists of three main components: (1) the Southeast Arizona Land Exchange, a congressionally mandated exchange of land between Resolution Copper and the United States; (2) approval of the GPO for any operations on NFS land associated with the Resolution Copper Project; and (3) amendments to the forest plan. Because the land exchange and forest plan amendment would be the same under the proposed action and all action alternatives, those aspects of the proposed action are described in Section 2.2.2, Elements Common to all Action Alternatives.

This section summarizes the components of the proposed action as described in detail in the GPO. For a full description of the proposed mining operation, including the construction, operation, closure, and reclamation phases of the proposed mine, please refer to the GPO, as amended, which is available online at http://www.resolutionmineeis.us/documents/resolution-copper-gpo or at the Tonto National Forest Supervisor's Office, 2324 East McDowell Road, Phoenix, Arizona 85006.

The description of the GPO is organized as follows:

1. The mine's main facilities (existing and new).
2. The mining processes and activities that would occur during operations of the mine.
3. The closure and reclamation processes that would occur, including financial assurance for reclamation activities.

The proposed action is composed of new mining facilities, existing mining facilities, and existing facilities that are proposed for expansion. The main facilities can be summarized as the East Plant Site, West Plant Site, tailings storage facility, and filter plant and loadout facility (figure 2.2.2-2). In addition, detailed information is provided for several linear corridors, including the ore conveyor/infrastructure corridor and the MARRCO corridor. Surface subsidence is also expected above the underground mine, and this subsidence area is described in relation to the underground mining process (see "Predicted Subsidence Area" later in this section). Table 2.2.2-1 summarizes the direct surface disturbance areas for each of the main mining facilities.

Mine Phases: Construction, Operation, and Closure and Reclamation Time Frames

The estimated overall life of the mine is 51 to 56 years and would consist of three phases: (1) construction, (2) operations, and (3) closure and reclamation. The time frames for these phases and the general activities that would occur under each phase are summarized in figure 2.2.2-3. The term "mine year" is defined as 1 year after the final ROD has been signed and the final GPO has been approved by the Forest Service.[14] These phases were initially defined in table 1.8-1 in the GPO[15] and showed a 45-year operations phase. Subsequent design work and analysis to support the DEIS refined the length of active mining to be 40 years.

14. Should construction implementation be substantially delayed after the GPO has been approved by the Forest Service (for example, by litigation), the Forest Service would review and update the trigger for tracking mine years. Terminology for mine phases is described further in Rigg (2017).

15. Multiple versions of the GPO exist. See the process memorandum titled "History of Revisions to General Plan of Operations" (Garrett 2016) for full details. The version of the GPO cited here is dated May 9, 2016 (Resolution Copper 2016d).

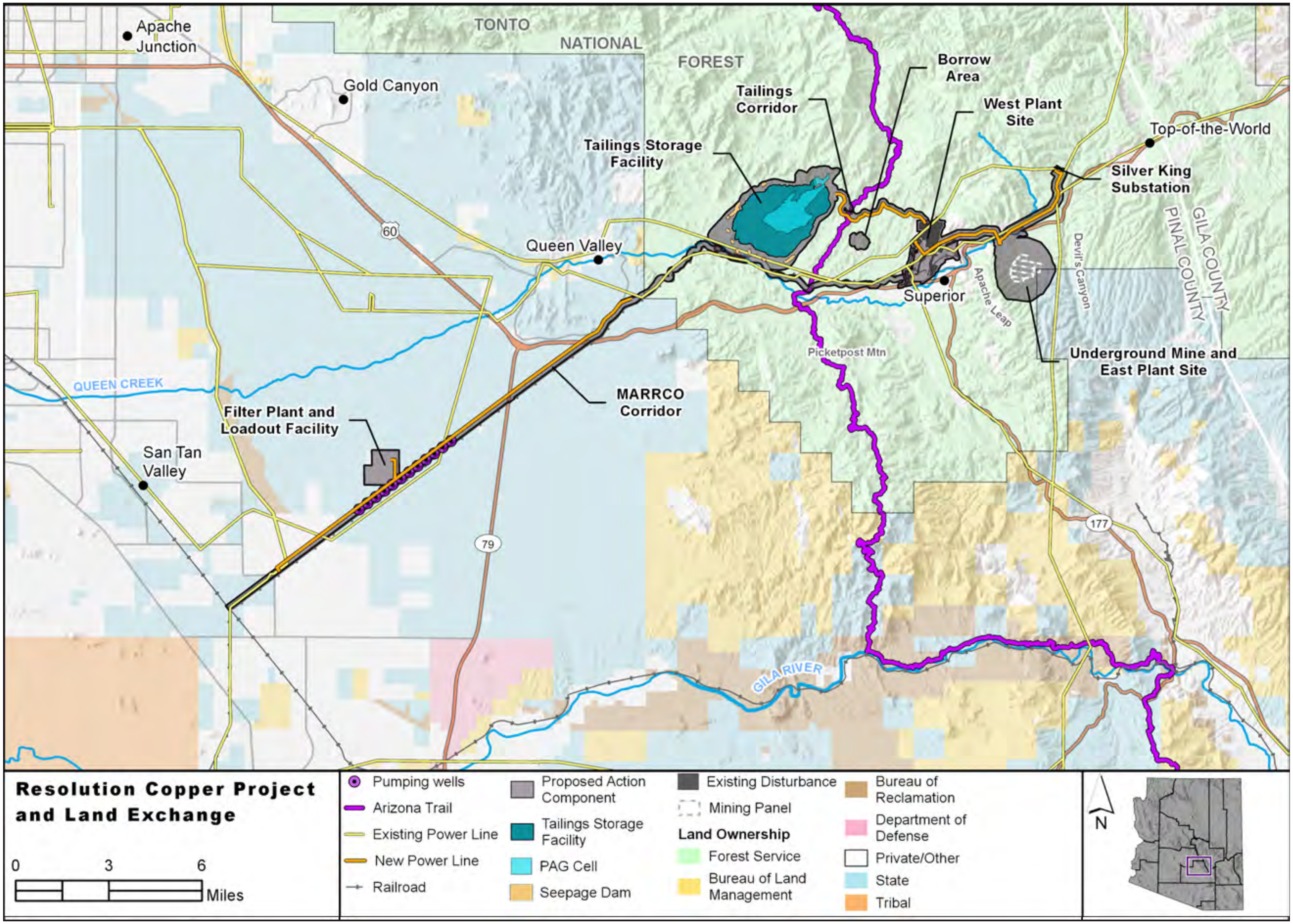


Figure 2.2.2-2. Alternative 2 – Near West Proposed Action overview

Table 2.2.2-1. Summary of project surface disturbance by proposed action

Facility	Total Disturbance (acres rounded to whole numbers)
East Plant Site (includes Magma Mine Road). Note that all NFS acreage shown in the East Plant Site would become private following the land exchange.	189 (140 NFS and 49 private)
West Plant Site	940 (all private)
Tailings storage facility and tailings pipeline corridor	4,986 (4,933 NFS, 53 private)
Filter plant and loadout facility	553 (all private)
Subsidence area. Note that all NFS acreage shown in the subsidence area would become private following the land exchange.	1,686 (1,501 NFS, 145 ASLD, 40 private)
MARRCO corridor	169 (65 NFS, 81 ASLD, 23 private)
Total	**8,523 (6,639 NFS, 226 ASLD, 1,658 private)**

Mining Process Overview

The Resolution Copper Mine, including all facilities described in this document, would operate 24 hours per day, 365 days per year. Figure 2.2.2-4 shows an overview of the entire mining process that would occur at full operation.

Mining the copper deposit would occur between approximately 4,500 and 7,000 feet below ground. At full operation, underground mining would produce 132,000 to 165,000 tons of ore per day. Ore would be crushed underground before being transported to two production shafts that would hoist the ore to an offloading station approximately halfway to the surface. From the offloading station, a conveyor system would transport the ore underground to the concentrator complex at the West Plant Site, approximately 2.25 miles west of the East Plant Site.

Once arriving at the concentrator complex, the ore would either be processed right away or stockpiled for future processing at a covered stockpile. The ore would then be conveyed into a concentrator building for additional crushing and grinding to a sand-size fraction and then further processed by flotation, whereby copper and molybdenum minerals are separated from non-economic minerals in a water bath with the addition of air and reagents. This process produces two products: molybdenum concentrate and copper concentrate. The molybdenum concentrate would be sent to the molybdenum plant for additional processing, packaging, and delivery to market via truck. Approximately 24,145 tons of molybdenum concentrate would be produced per year and sent to market during the operations phase. The copper concentrate slurry would be partially dewatered and pumped about 21 miles to the filter plant and loadout facility through two 8-inch high-density polyethylene (HDPE)-lined steel pipelines that would be located within the MARRCO corridor.

At the filter plant and loadout facility, copper concentrate would be filtered to remove more water and prepared for transport by railcar to Magma Junction for unloading at the Union Pacific Railroad. During the operations phase, between 6,000 and 7,000 wet tons per day of copper concentrate would be produced and sent out for smelting at an off-site smelter. The final smelter destination is unknown at this time. Water recovered during the filter process would be returned to the process water pond at the West Plant Site through the mine's main water supply pipeline in the MARRCO corridor.

The non-economic sand-like material that remains after the ore has been crushed and the copper and other valuable minerals has been extracted is called tailings. Tailings would be sent to a tailings storage facility approximately 4.7 miles west of the West Plant Site through two pipelines (42-inch pipe for NPAG, 2-inch pipe for PAG; reclaimed water would return to West Plant Site in a 24-inch pipe).

Approximately 1.37 billion tons of tailings would be created during the mining process and would be permanently stored at the tailings storage facility. Tailings leaving the processing plant would be split into two separate streams. About 16 percent of the tailings are classified as

Construction

Construction on Federal lands would begin after the final GPO is approved.

- Construction of new facilities at East Plant Site such as new shafts, new roads, new substation, and new refrigeration plant.
- Construction of new facilities at West Plant Site such as concentrator complex, process water pond, water treatment plant, substations, and new/rerouted roads. Ore processing facilities would be operational at approximately mine year 6 and would begin processing ore.
- Construction of the filter plant and loadout facility (completed by mine year 2).
- Construction activities at the tailings storage facility would include constructing new roads, an admin building, and soil stockpiling; however construction of the tailings storage facility would continue through entire mine life while tailings are being produced (see section 3.3.10.7 of the GPO for a detailed description of tailings storage facility construction phases).
- Construction of MARRCO corridor upgrades to accommodate new utilities.

Operations

All main facilities would be fully operational at mine year 6, although construction of ancillary facilities would still be occurring at various locations until mine year 9. Activities include the following:

- Mining 132,000 to 165,000 tons of ore per day. Ore would be excavated from the East Plant Site and processed at the West Plant Site every day for 40 years.
- Processing of ore into copper concentrate at the West Plant Site that would be transported through a pipeline within the MARRCO corridor to the filter plant and loadout facility.
- Processing concentrate further at the filter plant and loadout facility that would be sent via rail for delivery to off-site smelters.
- Piping approximately 1.4 billion tons of tailings from the West Plant Site to the tailings storage facility that would be stored in perpetuity.

Closure and Reclamation

After mining operations cease in mine year 50, closure and final reclamation would occur at the following disturbed surfaces:

- Decommissioning, removing, and/or closing facilities
- Recontouring and regrading disturbed surfaces
- Replacing growth media (i.e., stockpiled soils)
- Revegetating surfaces by seeding and/or direct planting of seedlings where appropriate
- Reclamation activities are not expected to only occur during this phase; some reclamation activities will occur concurrently during the construction and operations phases.
- Post-closure monitoring would continue after the closure and reclamation phase is completed, and long-term facility and water management would occur.

Figure 2.2.2-3. Mine phases, time frames, and mine activities by phase

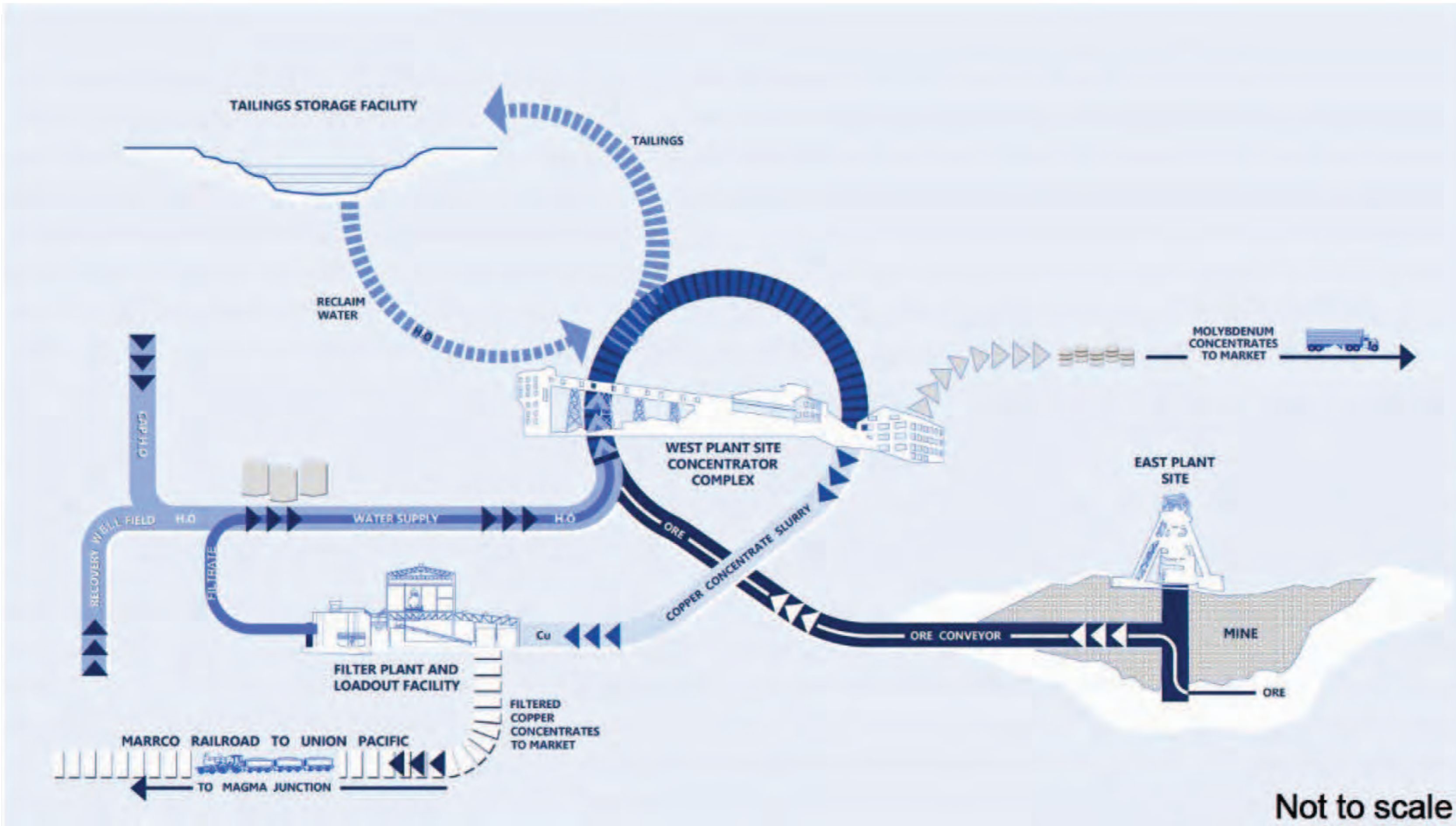


Figure 2.2.2-4. Overview of the mining process at full operation

potentially acid generating, or PAG tailings. These tailings contain much of the sulfides from the ore. The remaining 84 percent of the tailings are classified as non-potentially acid generating, or NPAG tailings.

The PAG tailings and NPAG tailings would arrive at the tailings storage facility separately. The PAG tailings would be deposited in such a way that they are kept submerged beneath water (known as "subaqueous deposition"). This limits oxygen from interacting with the concentration of sulfides in the PAG tailings, minimizing and preventing water quality problems (acid rock drainage). The NPAG are less reactive and would be deposited in a way that would eventually encapsulate the PAG tailings.

UNDERGROUND MINING

Resolution Copper proposes to mine the copper deposit under the Oak Flat Federal Parcel using a method known as panel caving. Panel caving would be the mining method used under all action alternatives. Other mining methods were considered but not analyzed in detail; for additional information, see appendix F. The following sections describe the panel caving method and the various other activities that would occur at the underground mine.

Panel Caving Overview

The type of copper deposit that would be mined at the East Plant Site is a porphyry deposit located between approximately 4,500 and 7,000 feet below the Oak Flat Federal Parcel. The copper deposit that Resolution Copper proposes to mine averages 1.54 percent copper (i.e., every ton of ore would on average contain 31 pounds of copper). The proposed action would use panel cave technology, a type of block caving that is a large-scale mining method.

In general, the panel caving mining system divides the ore into large sections or panels and depends on gravity and internal geological stresses to extract ore from underneath the ore body. After accessing the area below the copper deposit through the construction of vertical shafts, a network of tunnels (vertical shafts and horizontal drifts) is excavated under the copper deposit. The tunnels would be created by standard underground techniques, including drilling, blasting, and removing the blasted rock. The network of tunnels would have four levels, each with different functions, as described in table 2.2.2-2.

Table 2.2.2-2. Description of underground tunnel levels

Level	Function	Components
Undercut blasting	Blast ore body directly overlying the undercut blasting level	Drifts, shafts, and mechanical support
Extraction	Collect blasted ore	Drifts, shafts, mechanical support, drawbells, load-haul-dump vehicles, and ore passes and chutes
Exhaust	Circulate cool air from refrigeration system throughout underground mine operations	Drifts, shafts, ductwork, and variable-speed fans
Rail haulage and crushing	Transport ore from drawbells to underground crushing facility and then convey to production shafts	Drifts, shafts, crushing facility, mechanical support, haul trucks, and/or rail cars and rail system

Once the tunnels are built below the copper deposit, the ore above is blasted to fracture it. The ore then collapses downward through funnel points known as drawbells.

From the drawbells, the collapsed ore in the extraction level would be transported through the tunnel system to a crushing facility underneath the haulage level, where the ore would be crushed by one of three gyratory crushers. Once crushed, the ore would be conveyed to a production shaft where it would be hoisted approximately halfway to the surface (approximately 3,500 feet below surface) and sent from a loadout facility to the West Plant Site via the inclined underground to surface conveyor system.

After the ore has been blasted and collapsed into the drawbells, an expansion void (or cave) within the ore body would form. Additional fracturing and ore collapsing would occur at the expansion void as a result of internal geological stresses caused by the cave, at times aided by additional blasting. The continued process of collapsing

and excavating the ore would be repeated until the copper deposit is exhausted or the grade of the collapsed ore is no longer economically viable. Over the 40-year operations phase, this process would be applied at six panels adjacent to one another under the Oak Flat Federal Parcel (figure 2.2.2-5). The mining sequence would begin away from Apache Leap in Panel 2; subsequently mined panels would be Panels 3, 1, 4, 5, and 6, as shown in figure 2.2.2-5.

In total, about 600 pieces of mobile equipment would be used at the underground mining operations. This equipment is identified in table 2.2.2-3.

Refrigeration and Ventilation Systems

Heat in the underground mining operations would be generated by numerous man-made and natural thermal sources. The geological formation is naturally hot at the depth of mining, and in addition to this heat, other sources of underground heat and exhaust would be generated by vehicles and mobile equipment (both electric and diesel driven), workshops, warehouses, pump stations, the refrigeration plant, conveyors, the crusher station, and electrical substations. A refrigeration and ventilation system would be constructed at the surface at the East Plant Site to maintain appropriate temperatures in the underground mining operations and protect the health and safety of workers from excessive heat, equipment exhaust, gases, radon, respirable dust, and fibers. At full production, Shafts 11, 12, and 13 would be used as downcast fresh-air intake shafts, while Shafts 9, 10, and 14 would be used as upcast ventilation exhaust shafts, along with the conveyor/infrastructure tunnel exhaust raise. Mine shaft locations are shown in figure 2.2.2-7.

Underground Mine Auxiliary Facilities

Construction of auxiliary facilities within the underground mine workings would support the operations, including the following:

Table 2.2.2-3. Underground mobile equipment

Drilling and Blasting	
	Drilling Jumbos
	Production drills
	Explosives loader unit
Production and Haulage	
	LHD (Load, Haul, Dump Machines)
	LHD generator trucks
	Underground haul trucks
	Railroad locomotives
	Rail bottom dump cars
Secondary breaking fleet	
	Medium reach rigs
	Robust rigs
	Mobile rock breakers
Miscellaneous maintenance and service vehicles	
	Rock and cable bolters
	Shotcrete sprayer and trucks
	Scissor lifts
	Support trucks: fuel/lube, crane, water, shotcrete, Flat Deck, and service
	Graders
	Personnel vans and other vehicles

- Electrical substations, along with transmission and distribution systems, to provide power to the underground facilities and equipment.
- An underground workshop, warehouses, a batch plant, and fuel/tire storage to support mine operations.

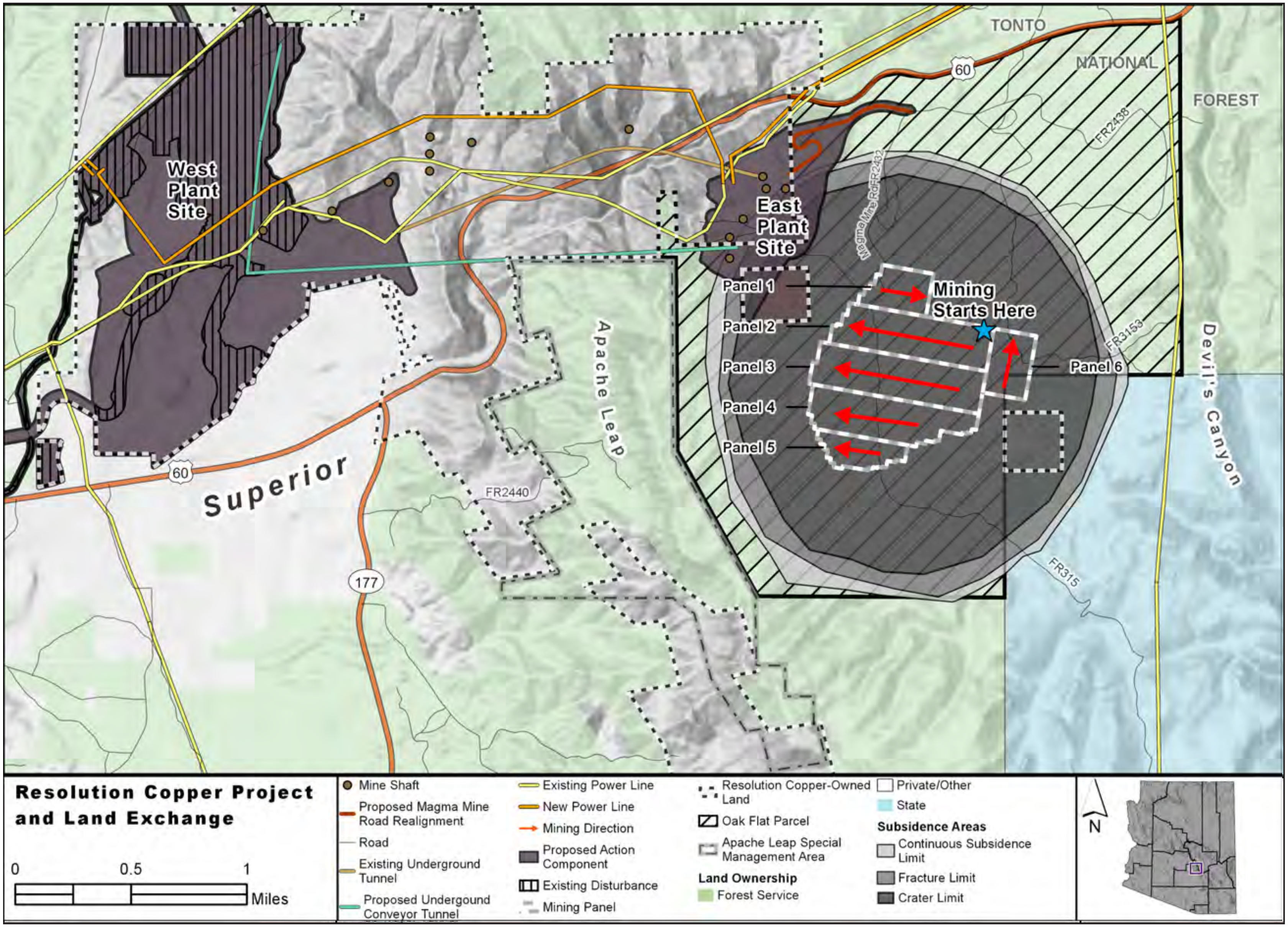


Figure 2.2.2-5. Predicted mining subsidence areas and the East Plant Site area

- Various pump stations, pipelines, and infrastructure necessary for dewatering water from underground mine workings and the transfer of process and cooling water in the mining circuit.

Predicted Subsidence Area

As the panel caving process is repeated, the volume of ore extracted from the underground mine is expected to cause the surface of the Oak Flat Federal Parcel to collapse or subside. The size and depth of the land surface depression is primarily affected by the depth and footprint of the mine.

The analysis of the environmental effects of mining is contained in chapter 3, including a detailed discussion of subsidence. However, the collapse of rock downward is also a fundamental aspect of how the panel caving technique works; therefore, subsidence is described briefly here as part of the proposed action.

Resolution Copper has conducted simulations and modeling to predict the potential area that would subside. The overall subsidence would consist of three areas: (1) the crater limit, (2) the fracture limit, and (3) the continuous subsidence limit. Table 2.2.2-4 identifies the characteristics of each of the three subsidence areas, as well as the acreages of each area that are predicted to occur under the proposed action.

Under the proposed action, mining would not occur within some sections of the 1 percent copper deposit shell nearest Apache Leap to minimize risk of subsidence at Apache Leap. Figure 2.2.2-5 shows a map of the predicted mining subsidence areas, and figure 2.2.2-6 shows a cross section and aerial views of the predicted subsidence areas.

Table 2.2.2-4. Characteristics and acreages of subsidence subareas

Subsidence Subarea	Characteristics	Predicted Acreage of Each Area
Crater limit	Large, visible crater with cave angles of 70 to 78 degrees and with a depth between approximately 800 and 1,115 feet at the end of mine life	1,329
Fracture limit	Visible deformation in a conical form between the surface and cave zone; characterized by rotational failures, tension and dislocation cracks, benching, fractured surfaces, and toppling	250
Subsidence limit	Extremely small rock deformations that can only be detected by high-resolution monitoring equipment (would not be visible in the soil or on the ground)	172
Total Area of Subsidence		**1,751**

Source: Garza-Cruz and Pierce (2017)

East Plant Site

The East Plant Site includes the surface support facilities for underground mining activities, including the access shafts (figure 2.2.2-7). The East Plant Site would expand from its current size of 39 acres to 189 acres. At present, 4 acres of the existing East Plant Site and 144 acres of the proposed East Plant Site are NFS lands; following the land exchange, all of the East Plant Site would be private. The 4 acres of the existing East Plant Site has been previously disturbed. These acreages do not include several other aspects of the East Plant Site, including the underground infrastructure for the panel caving, the mined panels themselves, or the surface subsidence area.

Details of existing East Plant Site facilities, new East Plant Site facilities, and materials used at the East Plant Site are summarized in appendix G.

Ore Conveyor/Infrastructure Corridor

Partially crushed ore from the East Plant Site underground mine operations would be transported to the West Plant Site concentrator complex via an inclined underground to surface conveyor system (see figure 2.2.2-7). The underground conveyance system would

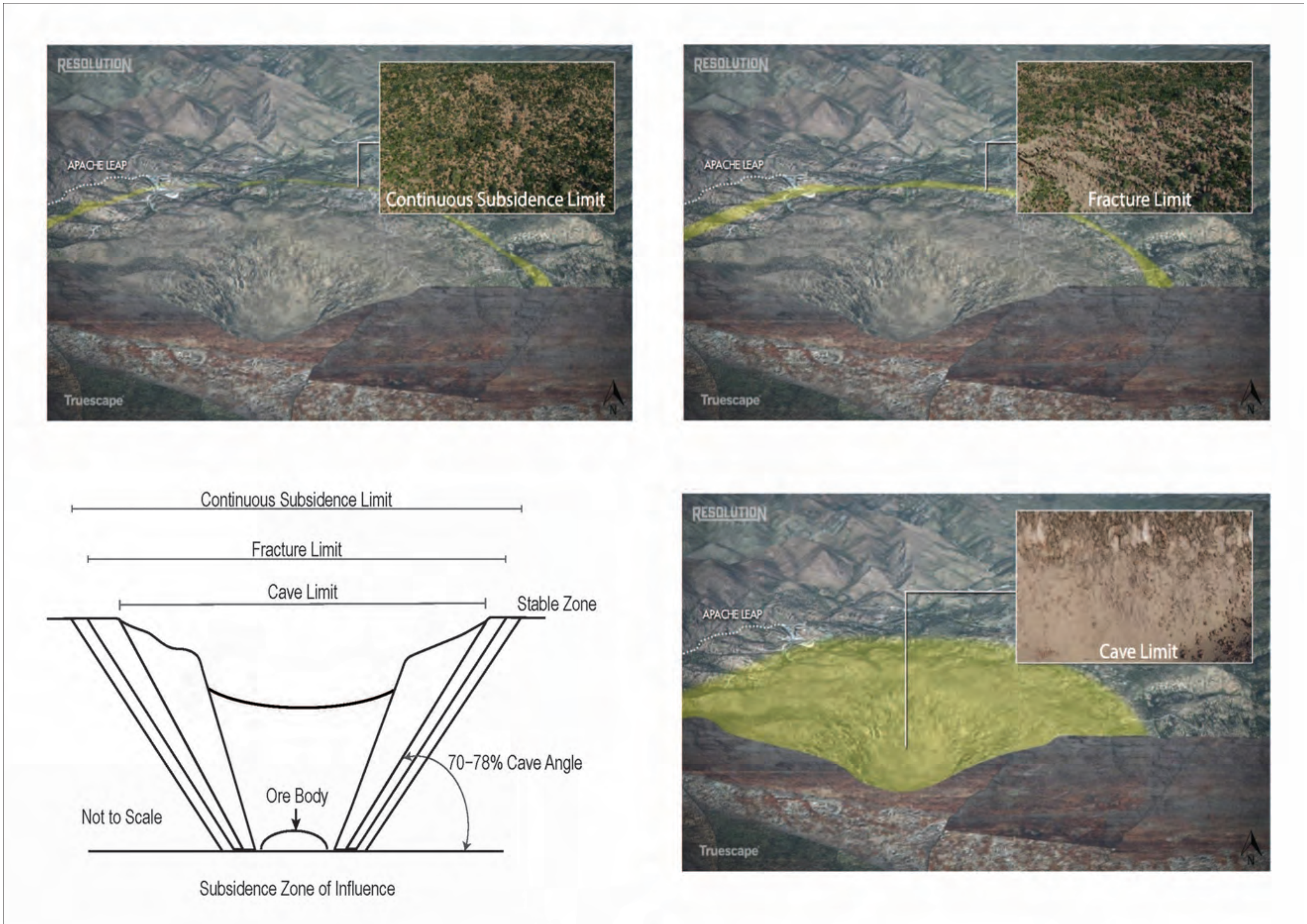


Figure 2.2.2-6. Cross section and aerial photograph simulations of the predicted subsidence areas

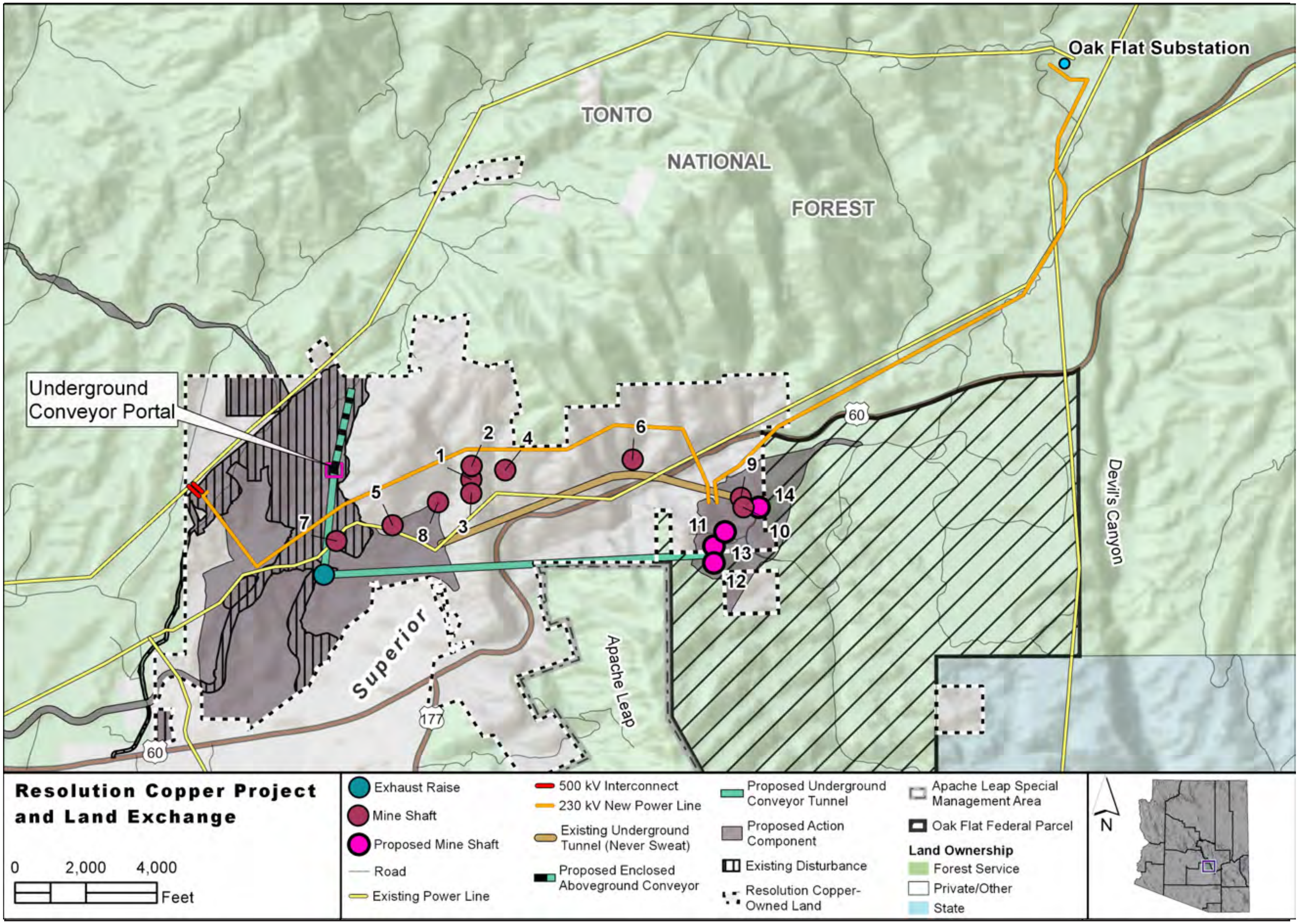


Figure 2.2.2-7. East Plant Site detailed facilities layout

be composed of an underground tunnel with two conveyors that are inclined at approximately 10 degrees for more than 2.5 miles. The alignment of the conveyance system would be under a combination of unpatented mining claims and private lands owned by Resolution Copper. Surface disturbance from the inclined underground to surface conveyor system would be limited generally to the shafts above the conveyor feed at the East Plant Site, an exhaust raise (and ventilation fans) along the conveyor tunnel alignment for ventilation, the tunnel portal at the West Plant Site, and the overland portion of the conveyor at the West Plant Site, all of which would be located on private land owned by Resolution Copper.

West Plant Site

In general, the West Plant Site would be the location where crushed ore material arriving from the East Plant Site would be processed into copper and molybdenum concentrates. The West Plant Site consists of three main facilities: (1) the stockpile, which includes the development rock and intermediate rock stockpiles; (2) the concentrator complex, which includes the process water pond, ore stockpile facility, tailings thickeners, copper molybdenum and copper concentrator thickeners (thickeners), and the molybdenum plant; and (3) the auxiliary facilities, which include the administration building, contractor and warehouse laydown yards, and construction and employee parking (figure 2.2.2-8).

The total footprint of the West Plant Site would be on private lands owned by Resolution Copper; 12 acres of the site are currently disturbed. The GPO had described a process pond on NFS land north of the West Plant Site, but it was determined that moving the process pond onto Resolution Copper private property directly to the west of the current West Plant Site would reduce impacts on NFS resources (see section 2.2.8.1 and figure 2.2.8-1).

Access to the West Plant Site would be via Silver King Mine Road (NFS Road 229), which is on both private and NFS lands. Portions of NFS Road 229 across private land would be reconstructed to Mine Safety and Health Administration (MSHA) specifications and maintained by Resolution Copper. This road would be used as an alternate road to transport mine personnel, equipment, supplies, and molybdenum and other mine products, to and/or from the West Plant Site. The alignment would generally follow the existing Silver King Mine Road with changes at drainage crossings and tight corners (see figure 2.2.2-8). Public access on NFS Road 229 would be controlled at a security gate where the road crosses private land. Alternative public access to areas north of the West Plant Site can occur on NFS Road 8 and NFS Road 3152 that would reconnect to NFS Road 229 north of the private land.

Details of existing West Plant Site facilities, proposed new West Plant Site facilities, and materials used at the West Plant Site are summarized in appendix G and shown in figure 2.2.2-9.

Tailings Storage Facility and Tailings Pipeline Corridor

Approximately 1.37 billion tons of tailings produced by the mining operation would need to be stored in perpetuity. The tailings corridors have been designed to follow existing roads or disturbance where possible. The proposed action and all alternatives would transport tailings within a corridor that would include multiple pipelines, an access road, and power and communication lines.

All action alternatives handle tailings in separate split streams based on the ore processing at the West Plant Site. PAG and NPAG tailings are transported in separate pipelines as they are split during the ore processing. The pipelines are designed for optimum performance during each mine phase to match flow characteristics of materials and velocity and vary between 10-inch, 22-inch, or 34-inch diameter. Recycled water would be transported back to the West Plant Site from the tailings storage facility via a 16-inch pipeline. The solids content of the tailings streams varies between alternatives; see figure 2.2.2-10 for ranges of tailings types at deposition.

The tailings conveyance corridors used to transport the tailings to the facility and reclaimed water back to the West Plant Site are designed with similar pipeline dimensions. Pipeline installation, spill containment necessary based on pipeline installation method, and access and bypass

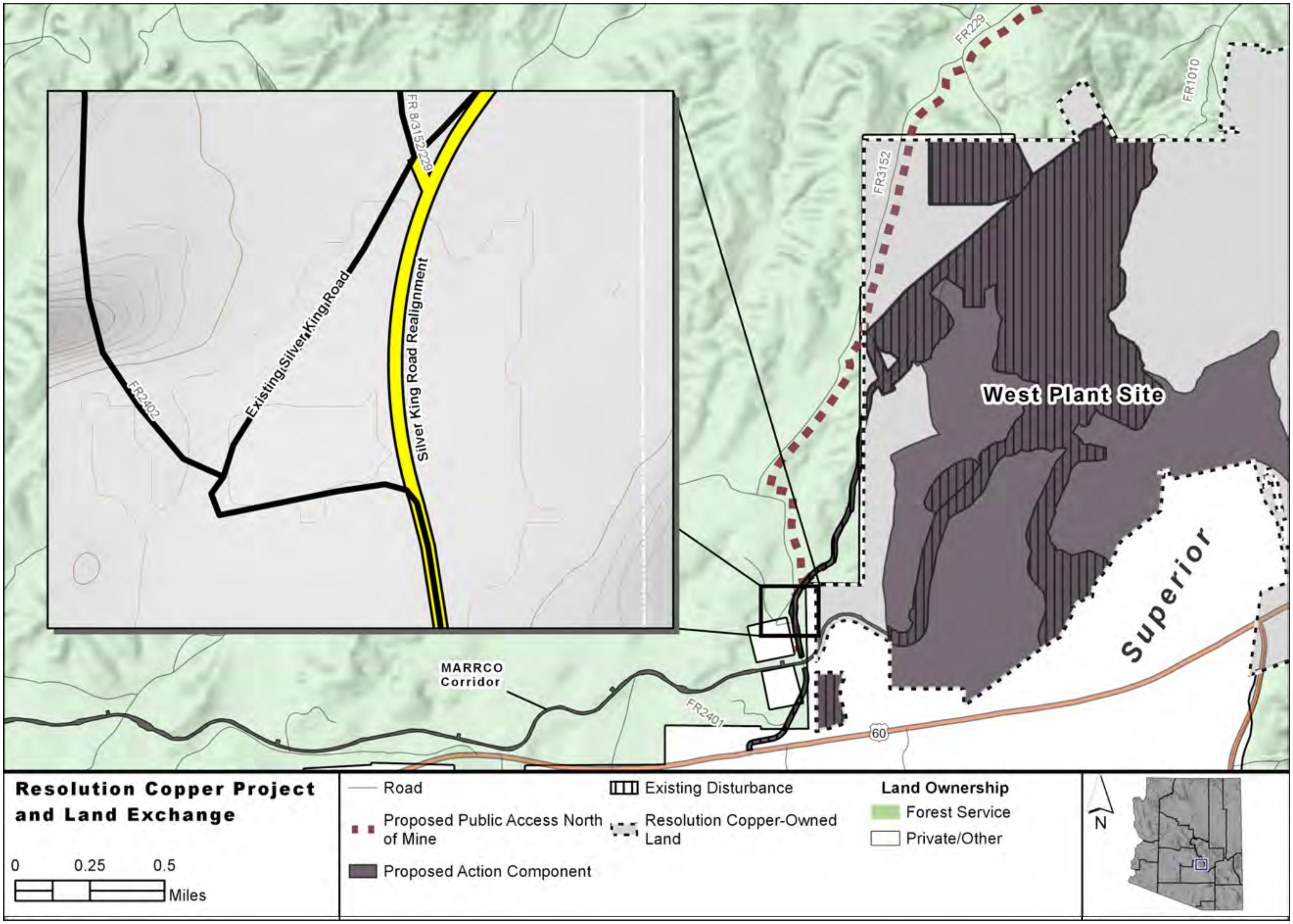


Figure 2.2.2-8. Redesign and/or improvement of vehicle access to and from the West Plant Site

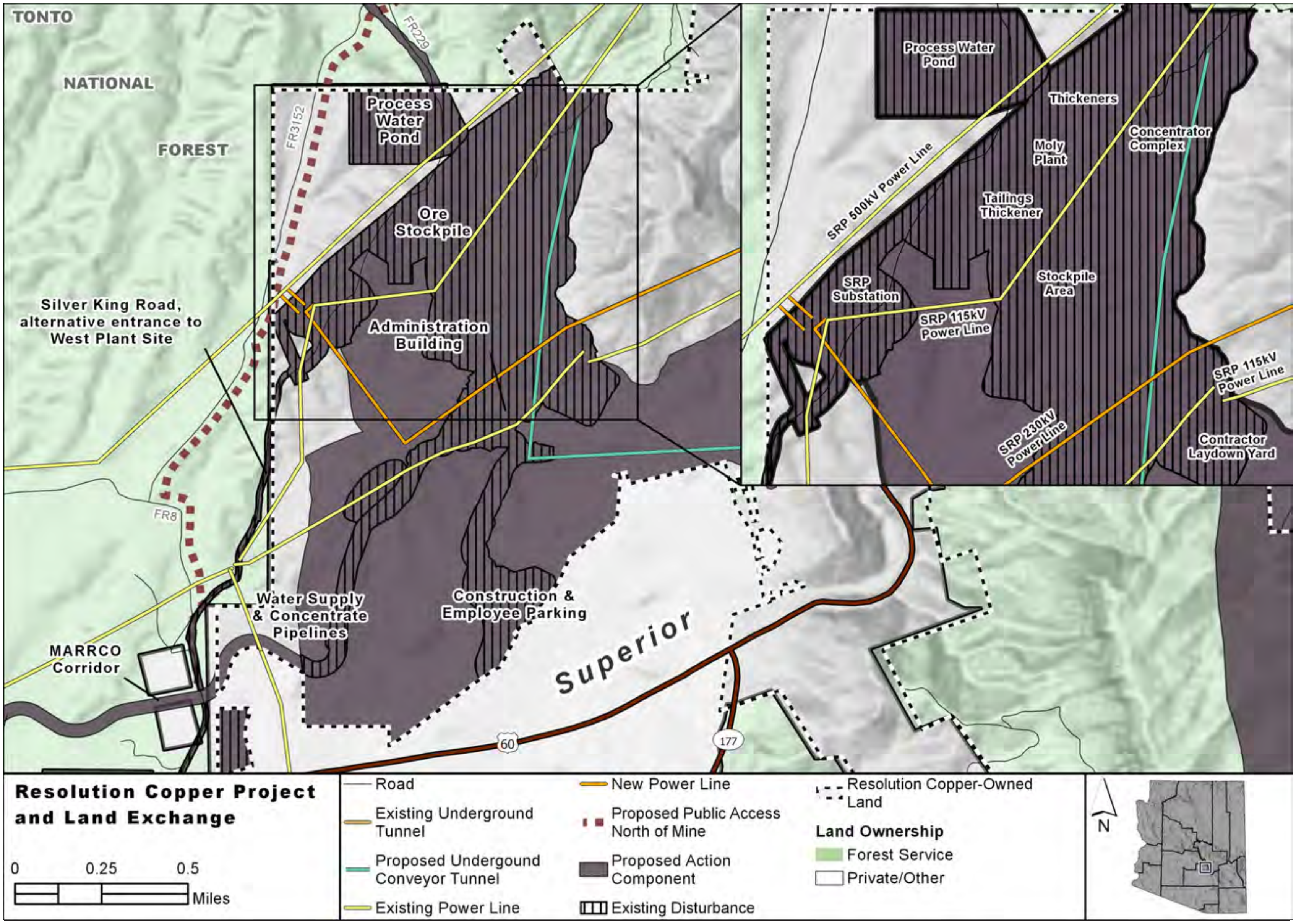


Figure 2.2.2-9. West Plant Site facilities overview

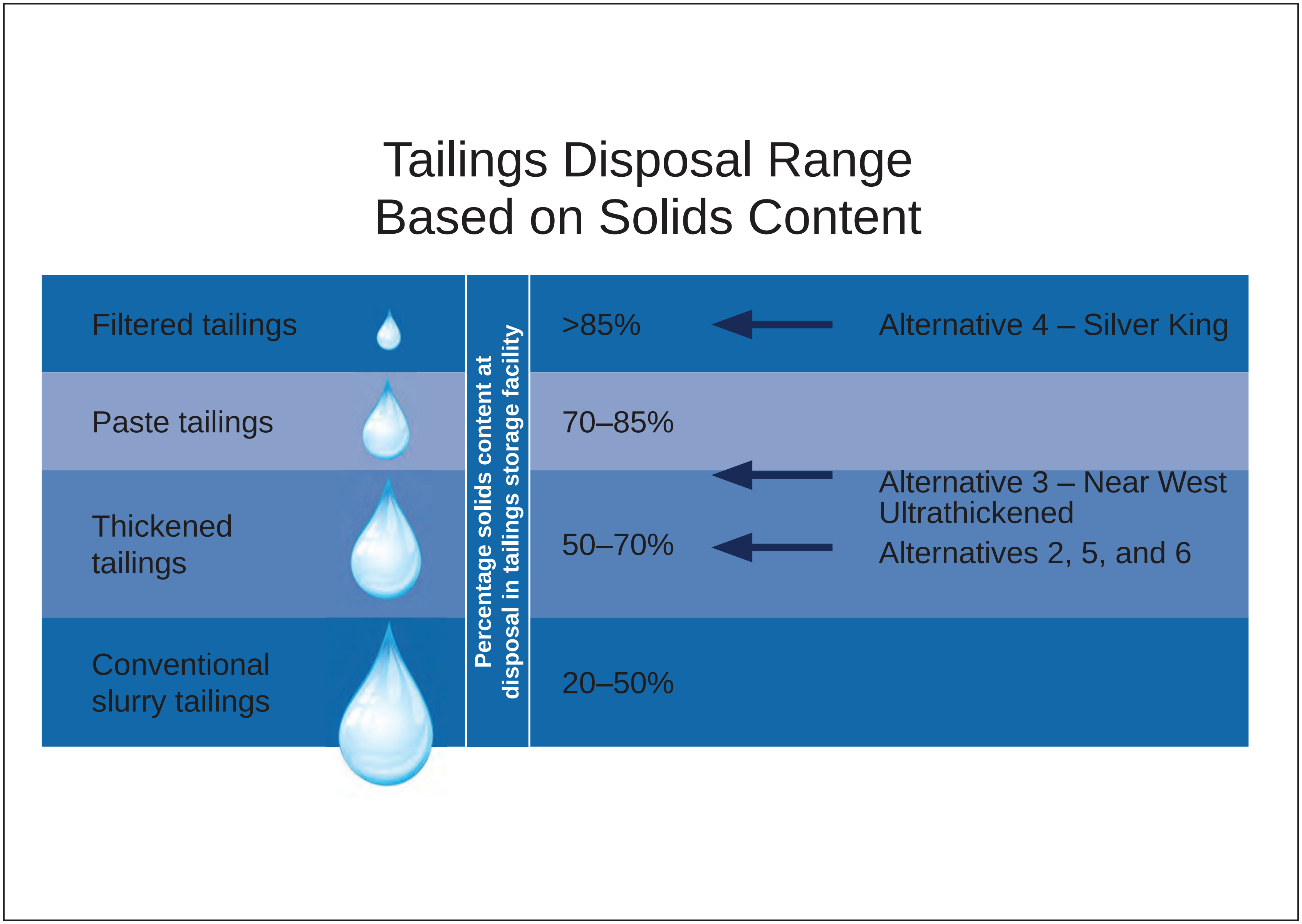


Figure 2.2.2-10. Range of tailings types based on solids content

roads necessary would vary by topography and alternative routing option selected. The pipeline design could include buried, overland secured, horizontal directional drilling (HDD) or micro-tunneling, surface run, cable-stayed bridge or through-truss bridge layouts. The installation designs would vary based on topography throughout each corridor segment and general design configurations are shown in figure 2.2.2-11.

The tailings conveyance corridor averages 110 to 230 feet wide, with the majority of the pipeline buried. In very steep sections of terrain, the corridor could be as wide as 1,000 feet. The pipeline would be equipped with a leak detection system and a modern control system permitting operation of the entire pipeline from a central control room. An access road that followed the pipelines would be used for construction, and maintenance during operations. Where necessary based on topography, other techniques could be used for pipeline construction, such as secured at the surface on overland secured placement, or through HDD or micro-tunneling at water crossings or through high mountain peaks. The pipeline can also span canyons, roadways, or trails such as the Arizona National Scenic Trail with cable-stayed or through-truss bridges. Booster pumps are required if unable to gravity-feed to the tailings storage facility; if necessary for design, the booster pumps would be located at the West Plant Site.

MARRCO corridor

The 30-mile-long MARRCO corridor is a railroad and utility corridor running roughly east-west from Superior to Magma Junction. Hewitt Canyon Road (NFS Road 357) provides access to the MARRCO corridor, which crosses private lands as well as lands administered by the Tonto National Forest and ASLD (figures 2.2.2-12 and 2.2.2-13). Resolution Copper currently owns the MARRCO corridor right-of-way. The corridor generally is 200 feet wide and private parcels along the MARRCO corridor have been developed, particularly east of Queen Station and near Magma Junction. The corridor currently contains multiple utility lines and water pipelines and infrastructure. The existing infrastructure within the corridor includes the following: a buried fiber-optic line, an overhead transmission line and telephone line, buried natural gas pipelines, Arizona Water Supply pipelines and infrastructure providing water supply to the Town of Superior, and an 18-inch dewatering line transporting water being dewatered from the East Plant Site to the New Magma Irrigation and Drainage District (NMIDD). New corridor facilities would include additional water pipelines, water pumps and recovery wells, and copper concentrate pipelines to transport ore concentrate to the filter plant and loadout facility.

Details of existing and new MARRCO corridor facilities are summarized in Appendix G, Further Details of East Plant Site, West Plant Site, MARRCO Corridor, and Filter Plant and Loadout Facility Infrastructure.

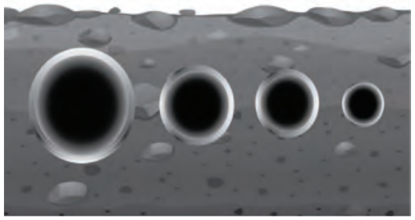
Filter Plant and Loadout Facility

A pipeline within the MARRCO corridor would transport copper concentrate slurry from the concentrator complex at the West Plant Site to the filter plant and loadout facility. The filter plant’s primary function would be to filter the copper concentrate to a state that is ready for transportation. The loadout facility’s primary function would be to remove water from the copper concentrate to prepare the concentrate for delivery to an off-site smelter and recycle water to be reused in the concentrator. The filter plant and loadout facility would be located on 553 acres of private lands controlled by Resolution Copper near San Tan Valley, Arizona (see figure 2.2.2-14).

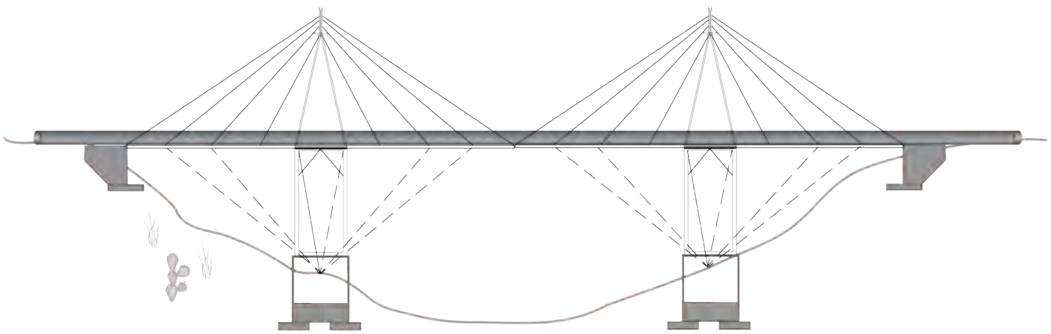
Carbon Steel Pipe Specifications and Use during Mine Life

Year of Operation	10-in. Diameter 0.375-in. Wall	22-in. Diameter 0.375-in. Wall 0.5-in. HDPE* liner	34-in. Diameter 1.25-in. Wall	16-in. Diameter 0.375-in. Wall
1–5 (ramp-up)	PAG	NPAG	–	Reclaim water
6 (ramp up)	PAG	–	NPAG	Reclaim water
7–41 (steady state)	–	PAG	NPAG	Reclaim water

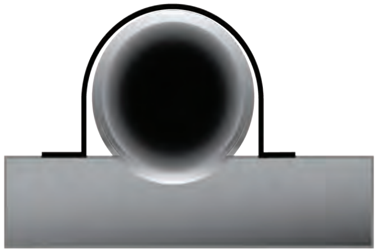
* HDPE:



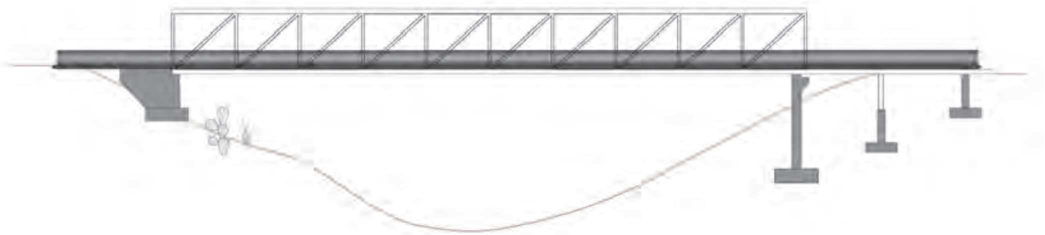
General arrangement of buried pipelines



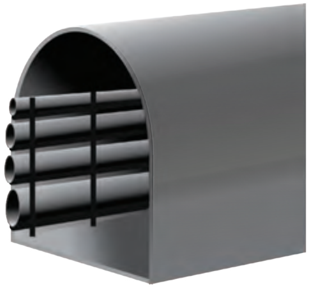
General arrangement of cable-stayed bridge – used for spanning canyons



Overland secured pipelines where construction is difficult due to bedrock



General arrangement of a through-truss bridge – used for spanning smaller channels



Horizontal directional drilling and/or micro tunneling will be used to undercut roads, waterways, or for high-point mountain passes

Figure 2.2.2-11. Graphical display of pipeline arrangements used in tailings conveyance corridor design

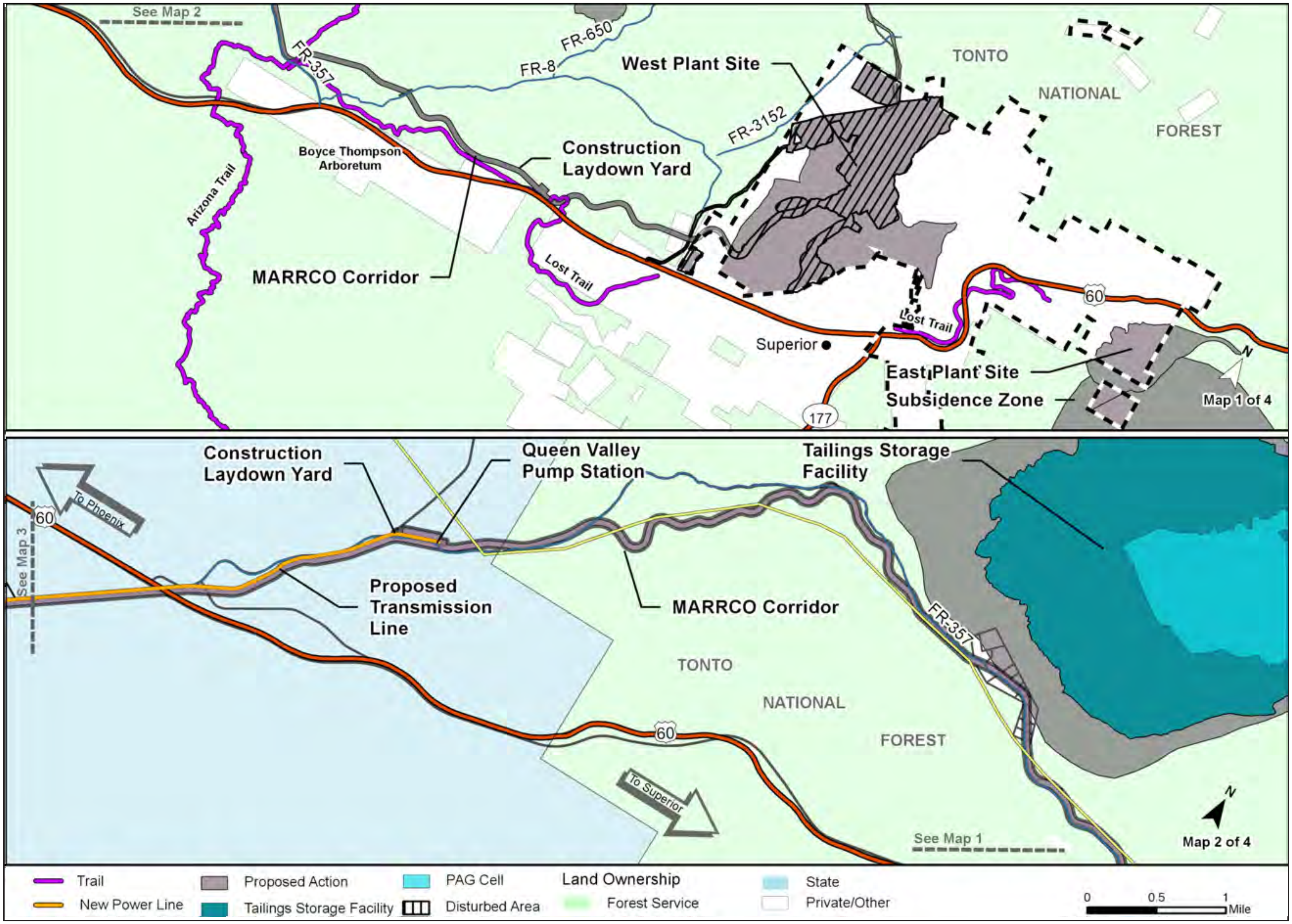


Figure 2.2.2-12. MARRCO corridor facility layout (1 of 2)

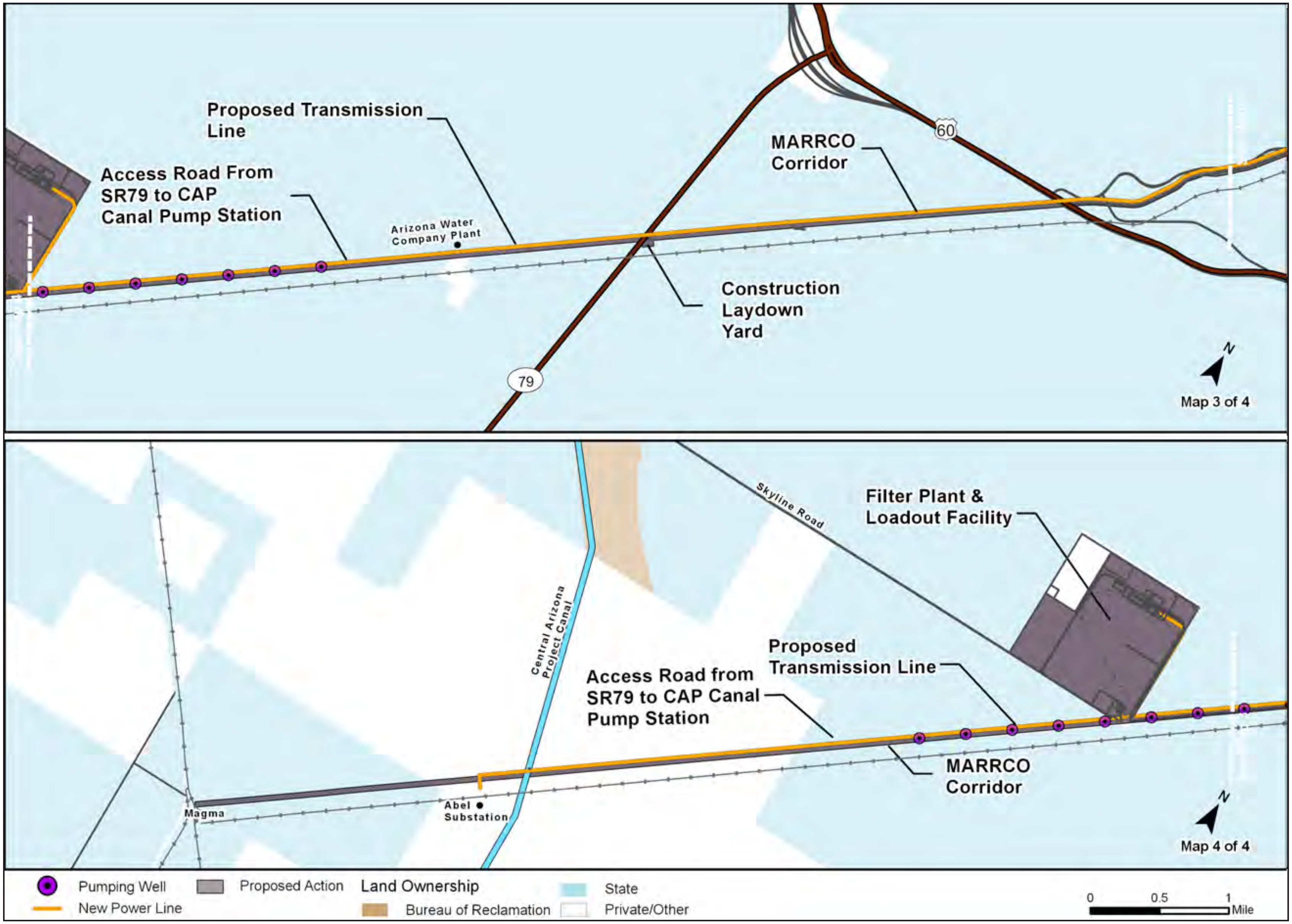


Figure 2.2.2-13. MARRCO corridor facility layout (2 of 2)

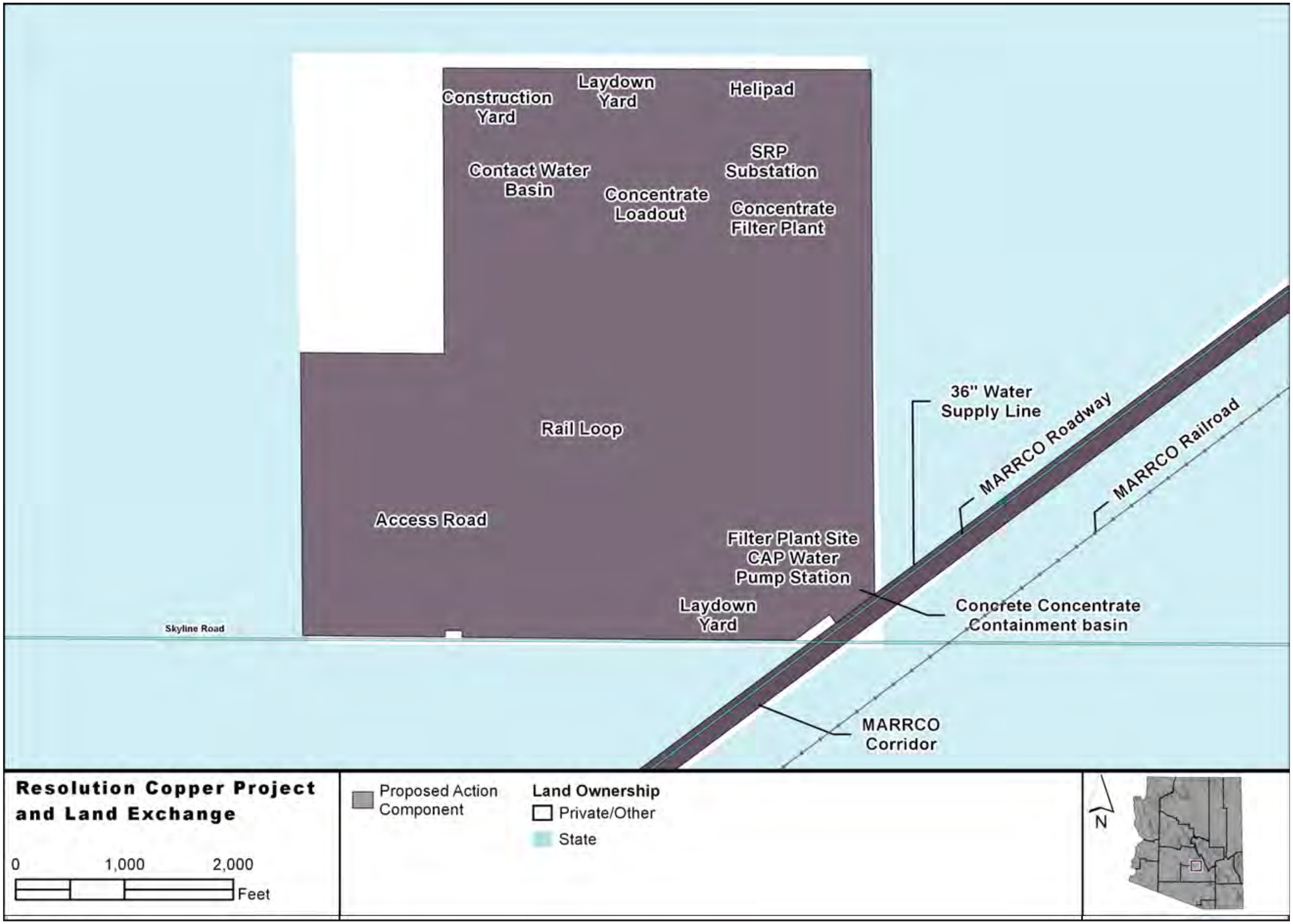


Figure 2.2.2-14. Filter plant and loadout facility detailed layout

Further details of East Plant Site, West Plant Site, MARRCO corridor, and filter plant and loadout facility infrastructure are summarized in appendix G.

Operations Processes and Activities

TRANSPORTATION

Each mine facility would have distinct access routes and traffic volumes during the construction, operations, and reclamation and closure phases. For detailed calculations of predicted traffic volumes that would be generated by the mine, including employee traffic, see the "Transportation and Access" resource section in chapter 3. Table 2.2.2-5 summarizes the access roads that would be used for each of the four main facilities and the materials and equipment deliveries that would occur during the construction and operation phases.

ELECTRICITY SUPPLY AND TRANSMISSION LINES

Electricity is currently supplied to the East Plant Site by an existing 115-kilovolt (kV) SRP transmission line and to the West Plant Site by an existing 500-kV SRP transmission line to existing facility substations. Construction and operation of the proposed mine would require electrical transmission lines between these main facilities to accommodate greater power needs, as well as new transmission lines to power the new tailings storage facility, new filter plant, and loadout facility. Substations also would need to be upgraded and/or new 230-kV substations would need to be constructed to accommodate electricity from the upgraded lines and distribute the electricity throughout the site (see East Plant Site, West Plant Site, tailings storage facilities, and filter plant and loadout facilities descriptions earlier in this chapter for upgraded/new substation descriptions).

Power use by the mine has been estimated (Garrett 2019b) Power use ramps up over time and varies slightly by tailings alternative, but during full operations is estimated to be approximately 250 to 280 megawatts. The primary electricity consumers at the mine site would be as follows:

1. The hoist motors at the East Plant Site that raise the ore out of the mine (roughly 20 to 25 percent of total power use), and underground ore flow (roughly 10 to 15 percent of total power use).
2. The ventilation and cooling systems at the East Plant Site for the underground mine (roughly 10 to 15 percent of total power use).
3. The operation of the grinding and flotation machinery at the concentrator complex at the West Plant Site (roughly 40 to 50 percent of total power use).
4. For Alternatives 5 and 6, pumping of tailings to the tailings storage facility (roughly 5 to 10 percent of total power use). Note that Alternatives 2 and 3 use gravity flow to deliver the tailings to the tailings storage facility, and do not require substantial power for tailings pumping.
5. For Alternative 4, filtering of tailings prior to placement (roughly 5 to 10 percent of total power use).

SRP would provide all electricity used at the mine facilities through the upgraded and new transmission lines. Figure 2.2.2-15 shows the proposed upgraded and new SRP transmission lines that would supply the main facilities with electricity. The Tonto National Forest would use analysis in this EIS to approve any rights-of-way and special use permits needed to construct the upgraded and new power lines.

Easements for the transmission lines would vary between 50 and 100 feet, depending on the size of the line and the requirements for construction, maintenance, and electrical clearances. Transmission lines would be either lattice steel towers or tubular steel poles. The foundations for the transmission line structures would be auger-drilled reinforced concrete piers. A lattice tower typically has four legs, each attached to a concrete foundation set into the ground. Steel pole structure footings are typically composed of a steel-reinforced concrete foundation referred to as an "anchor-bolt foundation," onto which the steel pole is bolted.

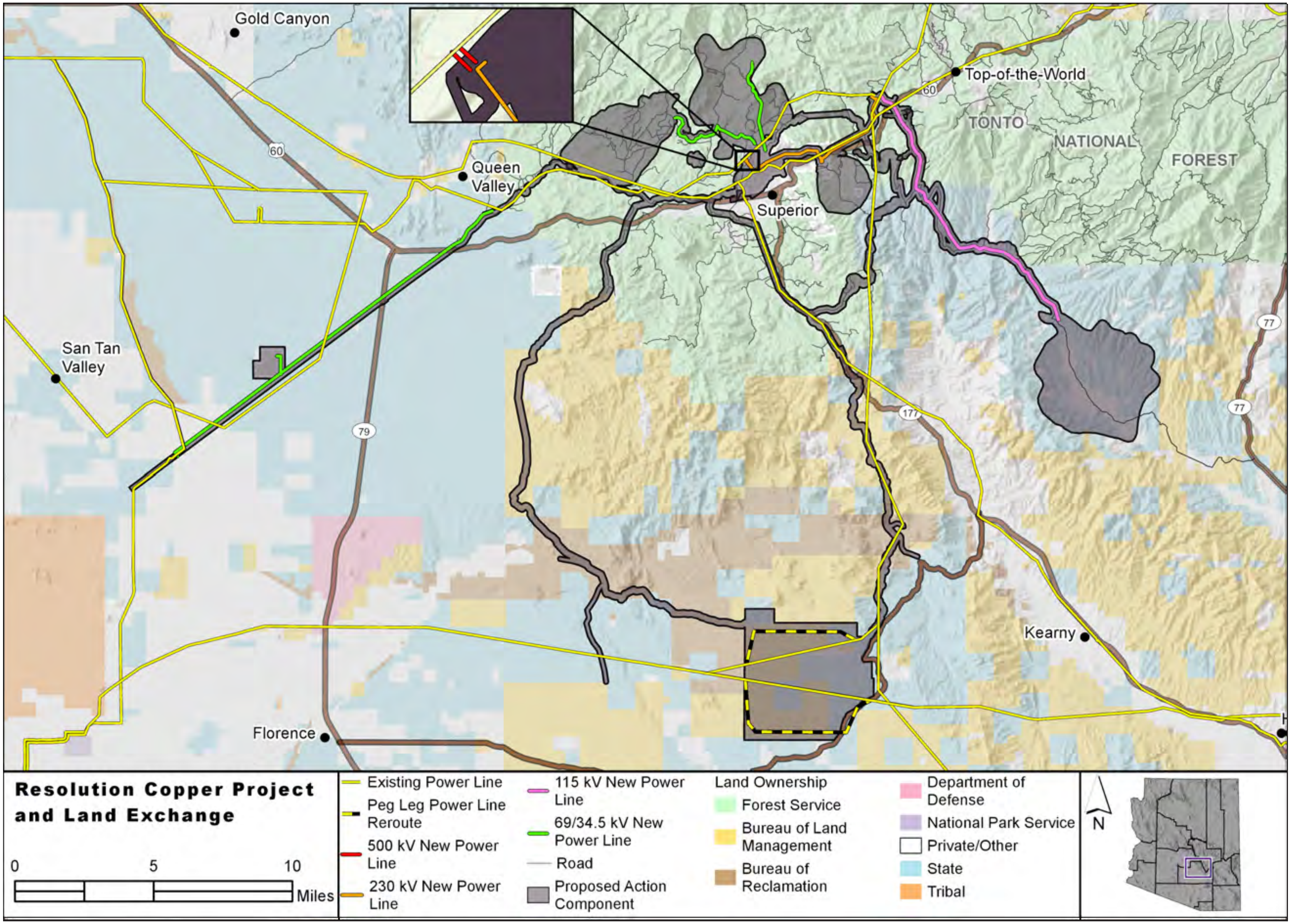


Figure 2.2.2-15. Proposed new and upgraded transmission lines

Table 2.2.2-5. Existing and proposed mine access roads and traffic

Facility	Access Routes	Construction Phase Materials and Equipment Traffic	Operation Phase Materials and Equipment Traffic	Closure and Post-closure Materials and Equipment Traffic
East Plant Site	Magma Mine Road from U.S. Route 60 (U.S. 60)	Materials deliveries would consist of fuel, underground concrete, underground production consumables, construction steel, other construction materials, and construction concrete. Major process equipment would be delivered over a 4-year period during the construction phase and would consist of crushers, conveyors, rail dump station, locomotives and railcars, ventilation equipment, hoisting equipment, dewatering equipment, and batch plants.	Materials deliveries would consist of fuel, underground concrete, and underground production consumables.	Salvageable equipment, unused chemical reagents, instrumentation, or other salvageable materials would be removed from site. Structures and other facilities would be demolished and/ or dismantled and removed from site. Any contamination would be disposed of as appropriate. Replacement of growth media for revegetation would be delivered if not enough found within the footprint or stockpile.
West Plant Site	Main entrance: Rerouted Silver King Mine Road (NFS Road 229) from U.S. 60 Existing entrance: Magma Avenue from U.S. 60	Materials deliveries would consist of concrete, rebar, structural steel, handrails/stairs, prefabricated buildings, chutes/launders, tanks, pipe, electrical equipment, overhead transmission line, semi-autogenous grinding mills, ball mills, and flotation cells. These shipments would occur during a 3-year period within the construction phase.	Materials deliveries would consist of semi-autogenous mill balls, ball mill balls, regrind mill balls, lime, sodium hydrosulfide, and miscellaneous reagents. Molybdenum concentrate shipments would leave the site daily from the concentrator complex.	Same as East Plant Site
Tailings storage facility	From U.S. 60 at three locations: service road adjacent to tailings pipeline corridors, Hewitt Canyon Road (NFS Road 357), and NFS Road 8	Materials and equipment deliveries would consist of pipe, valves, concrete, asphalt, and structural steel. These shipments would occur during a 3-year period within the construction phase.	Material deliveries would primarily consist of equipment and replacement equipment to operate spigots, recycle barges and pumps, and seepage collection systems.	Same as East Plant Site
Filter plant and loadout facility	East Skyline Road; rail via MARRCO corridor	Materials and equipment deliveries would consist of pipe, valves, concrete, asphalt, and structural steel. These shipments would occur during a 3-year period within the construction phase.	Filtered copper concentrate would be loaded and shipped 7 miles along the MARRCO corridor by rail car to Magma Junction where the rail line meets the Union Pacific Railroad. Final smelter destination is unknown at this time.	Same as East Plant Site

Table 2.2.2-6. Proposed new and upgraded transmission line summary

Facility	Transmission Line Route	New Alignment or Upgrade	Approximate Distance
East Plant Site	230-kV line from Silver King substation to Oak Flat substation	Upgrade	3.6 miles
West Plant Site	230-kV line from West Plant Site substation to Oak Flat substation	New	3.5 miles
West Plant Site	Double-circuit 230-kV connection from West Plant Site substation to the existing 500-kV and 230-kV lines at the West Plant Site	New	0.5 mile
West Plant Site	500-kV line to West Plant Site substation	No change	N/A
Tailings storage facility	35-kV line from West Plant Site substation to tailings substation	New	5.6 miles
Filter plant and loadout facility	Two 69-kV power lines and one 12-kV power line from Abel substation (near CAP canal crossing of MARRCO corridor)	New (adjacent to MARRCO corridor)	4.7 miles

Table 2.2.2-6 identifies the main transmission lines that would provide power to each mining facility.

Wherever possible, existing roads would be used to construct the transmission facilities. In some areas, access roads would be cleared on an as-required basis to ensure adequate access for construction and maintenance activities. Staging areas immediately surrounding line structures would be necessary, depending on specific site access. Permanent access roads would be constructed along the transmission line alignments that are located in drivable terrain.

WATER USE

Recycling and reuse happen extensively throughout the mine operations, but there are generally three major external sources of water: dewatering from the East Plant Site, direct use of CAP water, and recovery of banked CAP water and/or groundwater from wells located along the MARRCO corridor.

The estimated total quantity of external water needed for the life of the mine (construction through closure and reclamation) varies between alternatives. Resolution Copper proposes to use water either directly from the CAP canal or through wells along the MARRCO corridor in the East Salt River Valley. The water pumped is either considered banked CAP water, or water authorized by the State of Arizona to be pumped under a mineral extraction withdrawal permit, or a Type II non-irrigation grandfathered right. Regardless of the authority for obtaining the water, the water is pumped from the same wells. Currently, Resolution Copper has acquired approximately 313,000 acre-feet of renewable long-term storage credits within the Phoenix and Pinal Active Management Areas (AMAs). These include credits for CAP water banked at the NMIDD, Hohokam Irrigation Drainage District, and Roosevelt Water Conservation District groundwater savings facilities, credits for CAP water directly recharged at the Tonopah Desert Recharge Project, and purchase of renewable long-term storage credits from the Gila River Water Storage LLC. Resolution Copper has also applied for an additional 2,238 acre-feet per year allocation of CAP Non-Indian Agricultural water from the U.S. Department of the Interior Bureau of Reclamation; this application is not yet approved.

Figure 2.2.2-16 shows the general water supply and water use for each of the main facilities during operations of Alternative 2 – Near West Proposed Action. The water balance for the various mine facilities is complicated and varies by alternative. Further detail is included in Appendix H, Further Details of Mine Water Balance and Use.

In order to construct mine infrastructure, Resolution Copper currently removes groundwater from sumps in Shafts 9 and 10, effectively dewatering the deep groundwater system (the bottom of Shaft #10 is

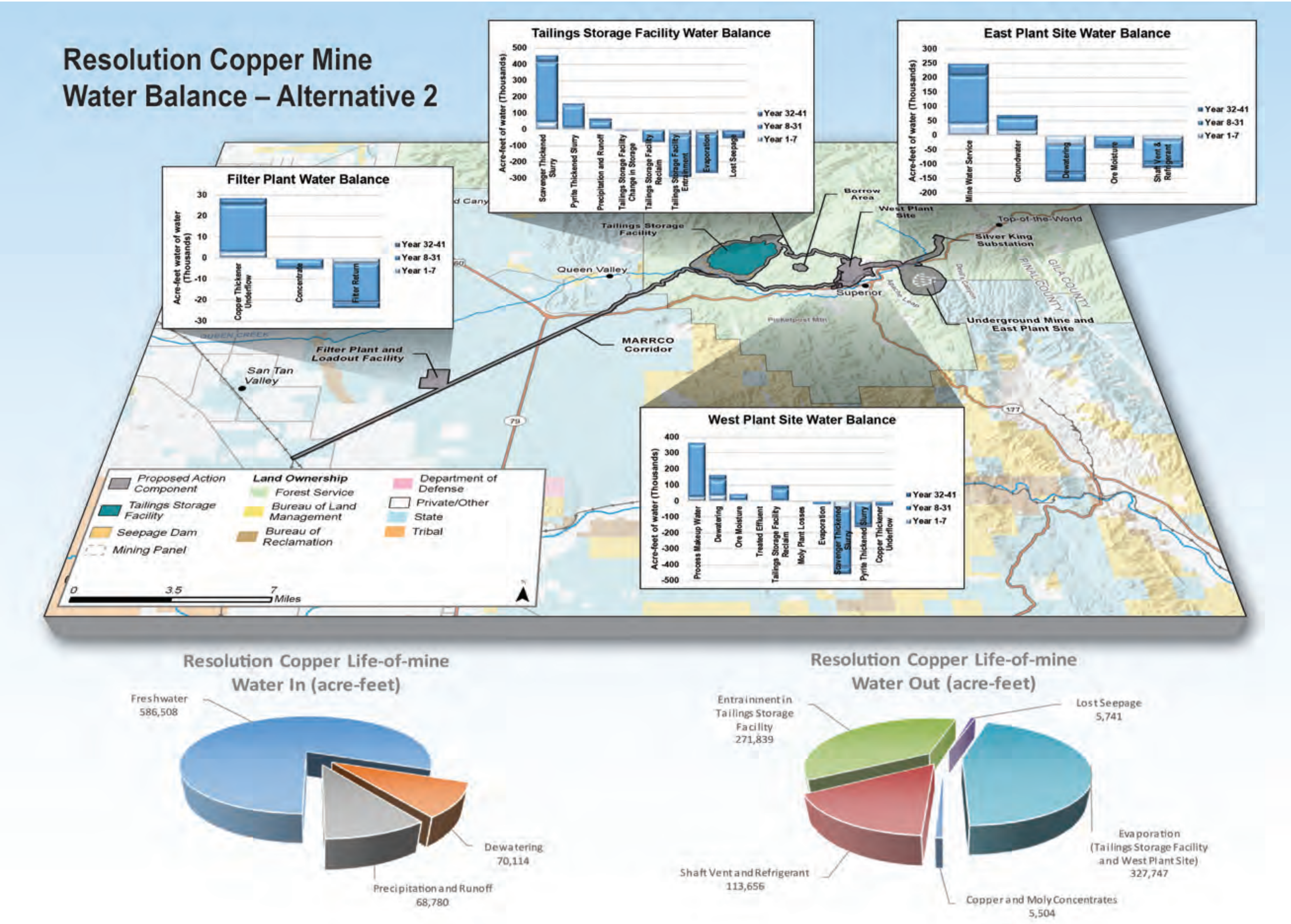


Figure 2.2.2-16. Alternative 2 – Near West Proposed Action water supply and water use diagram

about 7,000 feet below ground level). This dewatering started in 2009 and would continue throughout the mine life. When the mining begins, the block-cave zone would propagate toward the surface and effectively allow the effects of this dewatering to extend to more shallow aquifers as well.

SANITARY AND SOLID WASTE MANAGEMENT

New wastewater treatment plants would be constructed at both the East Plant Site and West Plant Site. Effluent from the East Plant Site wastewater treatment plant would be combined with the mine dewatering system, which would be delivered to the concentrator supply water pipeline for use in the concentrator.

Wastewater from the filter plant and loadout facility would be routed to an on-site septic tank and leach field. Septic solids would be removed and disposed of off-site as needed and in accordance with State laws.

Non-hazardous solid waste and special wastes (e.g., petroleum-contaminated soils) generated by any activities at the mine facilities would be disposed of in a manner consistent with applicable local, State, and Federal regulations. Resolution Copper drafted an environmental materials management plan that identifies the disposal method for each anticipated waste (Resolution Copper 2016b). Recycling programs currently used at the East Plant Site and West Plant Site would continue in an effort to reduce waste.

Waste is currently being disposed of and would continue to be disposed of in the following ways:

- Asbestos- and petroleum-contaminated soils waste streams would be managed in accordance with waste-handling protocols and disposed of at an approved waste facility.
- All trash and garbage would be hauled to State-approved landfills. Trash and garbage would be collected on-site in containers before being removed for disposal at permitted landfills. No open burning of garbage and refuse would occur at the project site.
- Wood and inert wastes such as concrete would be buried on-site as part of final closure and reclamation in selected areas in accordance with applicable county, State, and Federal regulations.

Closure and Reclamation

The closure and reclamation phase would occur after the 40-year operations phase and would have a duration of approximately 5 to 10 years.[16] A specific time frame for the closure and reclamation phase would not be known until after a final GPO is submitted to the Tonto National Forest and approved. The GPO describes the preliminary closure and reclamation plans that would occur at each of the main facilities and the linear features that connect them, as summarized in this section and within the GPO. The primary goals of reclamation are to

- stabilize areas of surface disturbance;
- prepare those areas for a post-mining land use that is compatible with surrounding uses; and
- ensure long-term protection of the surrounding land, water, and air resources

General Reclamation Procedures and Schedule

Although closure and reclamation would be a distinct phase after the operations phase during which the majority of the reclamation efforts would occur, the proposed action would employ three schedules of

16. Note that the time required for reclamation is heavily dependent on the methods used to construct and manage the tailings storage facility, and therefore reclamation timing varies substantially between alternatives.

reclamation throughout the life of the mine: interim, concurrent, and final reclamation.

INTERIM RECLAMATION

Interim reclamation would be completed on disturbed areas that are not needed, at the time, for active operations. The three main periods of interim reclamation are as follows: after construction, following startup, and during operations. The principal focus of interim reclamation would be to reduce erosion and sedimentation. Interim reclamation would include activities like the reclamation of road or pad cuts and fills and tailings surfaces (e.g., temporary covers, vegetation, or polymers to control wind and water erosion, thus limiting dust). Interim reclamation would allow temporary stabilization of certain sites, such as the tailings storage facilities during operations, for temporary dust control.

Other areas that would be subject to interim reclamation would include construction laydown areas, growth media stockpiles, development rock stockpiles designated for processing through the concentrator, and development rock stockpiles salvaged for beneficial use. Areas would also include access roads used for construction but no longer needed during operations. Additionally, the slope of the tailings storage facility might receive temporary reclamation for dust control measures in advance of concurrent reclamation.

Interim shutdown would include the suspension of mining, production, or other operations, or placing the facility into standby status. Interim shutdown is not anticipated based on the mining method used with all alternatives analyzed in the DEIS. It is unlikely Resolution Copper would have to suspend operations for purely economic reasons during the 10-year ramp-up period or the following 20 years of full production, since the project incurs most capital costs prior to mining and during construction and ramp-up of operations. If interim shutdown were to occur, personnel and processes to ensure compliance with permits and regulations, along with protecting infrastructure, would continue.

In the event of a shutdown, the following activities would still occur:

- Measures to stabilize excavations and workings with inspections and maintenance,
- Measures to maintain the general project area in a safe condition in compliance with MSHA safety regulations,
- Measures to manage regulated materials (hazardous materials) in accordance with applicable requirements,
- Measures to maintain access and utilities would continue to function, and
- Plans for managing water systems and maintaining facilities as required by the Stormwater Pollution Prevention Plan (SWPPP), Aquifer Protection Permit (APP), and Arizona Pollutant Discharge Elimination System (AZPDES). Dewatering and treatment of water from the mine infrastructure would continue, and the water would be discharged.

CONCURRENT RECLAMATION

Reclamation completed during operations is termed concurrent reclamation. Concurrent reclamation differs from interim reclamation in that this reclamation is designed to provide permanent achievement of reclamation goals and performance standards. Resolution Copper would implement concurrent reclamation of the outer slopes of the tailings storage facility, where practicable, as the operation progresses.

FINAL RECLAMATION

Final reclamation efforts would occur for a duration of 5 to 10 years after the operations phase. The general steps to be used in reclaiming disturbed areas at the mine are

- decommissioning facilities,
- removing and/or closing structures and facilities,
- recontouring and regrading,

- replacing growth media (i.e., store and release cover design for tailings), and
- seeding and/or direct seedling plantings where appropriate.

The final reclamation efforts that would occur at each of the main facilities are described in the following text.

EAST PLANT SITE CLOSURE AND RECLAMATION

Reclamation at the East Plant Site would consist of salvaging and demolishing all buildings, except for the headframes and hoists, which would be used for post-closure groundwater monitoring. All salvageable and non-salvageable materials would be disposed of off-site. All disturbed surfaces except those needed for long-term monitoring, including paved and graveled areas, would be regraded and reseeded with appropriate local seed mixes. Contact water basins would be closed in accordance with APP requirements. Shaft collars and subcollars would be permanently sealed by an engineered seal.

Reclamation activities would not occur within the subsidence area. There would be a berm and/or fence constructed around the perimeter of the continuous subsidence area. To the extent practicable, surface water diversions would be constructed to divert stormwater away from the subsidence area and into natural drainages.

During operations, the potential for adverse water quality in the panel caving area involves many factors, due to the potential exposure of mine rock to both oxygen and water; water quality concerns during operations are explored in section 3.7.2. After completion of mining, the underground panel caving area would not be expected to be a continuing source of adverse groundwater quality. There would be a thick overlying layer of rock above the panel caving area, and this rock is generally inert or acid neutralizing (over 80 percent of the samples analyzed of Apache Leap Tuff are non-acid generating; see section 3.7.2). Water percolating through the overlying rock would help neutralize acidity in remaining non-economic rock in the panel caving area. Rising groundwater levels would eventually flood the panel caving area completely, isolating it from oxygen and controlling further chemical weathering.

WEST PLANT SITE CLOSURE AND RECLAMATION

The West Plant Site facilities would be decommissioned, and the land surfaces would be contoured and graded as necessary to blend into the surrounding topography and terrain and reseeded with appropriate local species seed mixes. The post-closure grading plans for the West Plant Site include the following:

- All fill slopes would be laid back to a maximum of 2.5:1.
- The West Diversion Channel, the East Stormwater Channel, and an on-site channel would remain in place to route flow through a new diversion channel to the Apex Tunnel to existing drainages (e.g., Silver King Wash).
- The process water pond located at the western portion of the West Plant Site would be closed in accordance with APP conditions.
- Contact water basins would be closed in accordance with APP requirements.
- The emergency overflow ditch from Contact Water Basin W1 would remain in place.
- Non-contact water basins would be graded to drain.

Roads that are necessary to support the reclamation and closure efforts would remain to provide access to monitoring stations and remediation areas. All other roads would be reclaimed. All buildings would be salvaged or demolished, and all materials would be disposed of off-site. All portals, ventilation shafts, and tunnel entrances would be decommissioned, capped, and reclaimed at the surface.

TAILINGS STORAGE FACILITY CLOSURE AND RECLAMATION

Closure details differ for each tailings alternative primarily with respect to the length of time needed for closure and with respect to the method for long-term management of seepage. The overall closure process is similar for all tailings facilities. The recycled water ponds on the slurry tailings facilities would gradually be reduced in size as closure occurs, and the PAG tailings would be covered with a layer of NPAG tailings with timing dependent on the surface being dry enough to allow equipment access for reclamation. The seepage and runoff collection ponds generally would remain in place and would not be decommissioned until seepage water quality meets standards for release. Until that time, the ponds primarily would be used to evaporate seepage. Any excess draindown not evaporated from the seepage ponds would require active management. Active management could include pumping to another location, increasing evaporation using spray evaporators, or releasing water to the environment after appropriate treatment. The final method of post-closure management for seepage collection water would be determined as the project progresses through the NEPA process and engineering design. The final post-closure management plan would be based on overall expected volumes, anticipated seepage rates, and duration, in combination with the water chemistry assessment.

Additional final reclamation activities at the tailings would include contouring the tailings, installing riprap and erosion controls, covering the tailings with a combined armor protection (rock) and growth medium as an exterior shell, and revegetating the embankments and top of the covered tailings with a Forest Service–approved seed mix. The minimum depth of the exterior shell on the embankments would be 1.5 feet and would be thicker in areas where erosion protection would be required. Materials used for the exterior shell would be sourced from borrow pits and salvaged soil. The area within the tailing storage facility footprint would be used as a source, as well as an approximately 90-acre parcel 1 mile east of the tailings storage facility and 1.5 miles west of the West Plant Site. Any borrow area not underneath the tailings storage facility that is used for the shell would ultimately be recontoured and revegetated using a Forest Service–approved seed mix.

A perimeter fence or berm would be constructed around the tailings storage facility to prevent access. Some surface water diversion structures would be revegetated to control water and wind erosion, while others would be reconfigured to carry water along topography through and off the site. The diversion structures that would stay in perpetuity would be reconstructed with riprap to minimize erosion. All buildings, including foundations, at the tailings storage facility would be salvaged or demolished, and all salvage materials and demolition debris would be disposed of properly off-site. Roads that would not be required for closure and reclamation activities would be decommissioned, recontoured, and revegetated. All piping and electrical infrastructure connecting the tailings storage facility to the West Plant Site would be removed, leaving only the road and berms.

FILTER PLANT AND LOADOUT FACILITY AND MARRCO CORRIDOR CLOSURE AND RECLAMATION

All buildings, including building foundations, at the filter plant and loadout facility would be salvaged or demolished, and the salvaged material and demolition debris would be disposed of properly off-site. Tanks and ponds would be closed and reclaimed in accordance with APP and AZPDES permit requirements. All disturbed areas would be regraded with the exception of the diversion channel on the north side of the facility that routes surface water flows around the site to existing drainages.

The closure and reclamation of the MARRCO line is undetermined because the intended post-closure use of the railroad and utility lines is not known. Resolution Copper does not foresee a use of the railroad or utility lines for project reclamation or post-closure use, but another entity might buy the facilities and continue use. The concentrate lines, however, would be removed from the MARRCO corridor, and direct surface disturbance areas would be recontoured and revegetated to the extent possible with adjacent utilities. Bridge structures would be assessed and either removed or upgraded.

WATER SUPPLY FACILITIES AND PIPELINES CLOSURE AND RECLAMATION

Facilities associated with fresh water supply and distribution, such as pipelines, pump stations, and water tanks, may have a post-mining use and may be transferred to a third-party utility or community to provide water transport to the Superior Basin. No closure or reclamation activities would occur at these facilities if they were to be transferred to a third party.

Facilities that would not have a post-mining use include the tailings slurry lines, concentrate pipelines, and associated pump station with electrical power. These facilities would all be decommissioned and removed. Buried and aboveground pipelines would be removed and scrapped or salvaged. All disturbed areas would be recontoured and reseeded.

POWER TRANSMISSION FACILITIES CLOSURE AND RECLAMATION

Power transmission facilities, which include electrical substations, transmission lines, and power centers, may be removed as part of the reclamation program, unless a post-mining use is identified. SRP would continue to own the power lines and may have a post-mining use for ongoing power transmission in the area.

RECLAMATION FINANCIAL ASSURANCE

Resolution Copper would be required to establish and maintain sufficient financial assurance in accordance with requirements from the Forest Service, ASLD, BLM, the APP program, and the Arizona Mined Land Reclamation Act. The purpose of financial assurance is to ensure that responsible agencies would be able to continue any remaining reclamation activities if Resolution Copper becomes unable to meet reclamation and closure and post-closure obligations under the terms and conditions of the applicable permits and approvals. Under the Arizona Mined Land Reclamation Act, the Arizona State Mine Inspector would receive financial assurance for reclamation and closure activities required on private lands, the Forest Service would receive financial assurance for reclamation and closure activities on lands managed by the Forest Service previously described in section 1.5.5, and BLM would receive financial assurance for reclamation and closure activities on BLM-managed lands. The APP program would receive financial assurance for reclamation and closure activities for facilities that have the potential to discharge water into the groundwater (tailings storage facility, process ponds, and stormwater ponds), regardless of the facility’s location on private or NFS lands.

The cost estimates for the reclamation financial assurances are based on the final design of the facility, would be developed after the NEPA process, and would not be finalized until the final GPO is approved.

The release of all or a part of the reclamation performance bond would only be made by the appropriate agencies after Resolution Copper’s request has been reviewed for completeness and on-the-ground compliance with the predetermined release criteria and monitoring data, and after representatives of the agencies have conducted field and data examinations to ensure that reclamation activities have been implemented. Additional information on post-closure financial assurances can be found in section 1.5.5 and in several resource sections of chapter 3, including sections 3.3 (Soils and Vegetation), 3.7.2 (Groundwater and Surface Water Quality), and 3.10.1 (Tailings and Pipeline Safety).

2.2.3 Alternative 1 – No Action Alternative

Under the no action alternative, current management plans would continue to guide management of the project area. The Forest Service would not approve the GPO, none of the activities in the final GPO would be implemented on NFS lands, and the mineral deposit would not be developed. However, note that certain activities are currently taking place on Resolution Copper private property, such as reclamation of the historic Magma Mine; exploration; monitoring of historic mining facilities such as tailings under existing State programs and permits; maintenance of existing shaft infrastructure, including dewatering;

and water treatment and piping of treated water along the MARRCO corridor to farmers for beneficial use. These types of activities would be expected to continue, regardless of approval of the GPO. These activities are therefore assumed to occur in the no action alternative (Garrett 2018c).

This alternative is required by regulation (40 CFR 1502.14(d)). The nature of the no action alternative was described in the NOI issued for the project in March 2016. The NOI also indicated this alternative cannot be selected by the Forest Service but serves as a point of comparison for the proposed action and action alternatives.

The no action alternative includes the following:

- The final GPO would not be approved, thus, none of the activities in the final GPO would be implemented, and the mineral deposit would not be developed;
- The land exchange would not take place;
- Certain ongoing activities on Resolution Copper private land, such as reclamation of the historic Magma Mine, exploration, monitoring of historic mining facilities such as tailings under existing State programs and permits, maintenance of existing shaft infrastructure, including dewatering, and water treatment and piping of treated water along the MARRCO corridor to farmers for beneficial use, would continue regardless of GPO approval;
- Ongoing trends not related to the proposed project would continue, such as population growth, ongoing impacts on air quality from fugitive dust and vehicle emissions, human-caused fires from recreation, ranching, and a corresponding increase in use of public lands; and
- No agency land and resource management plans would be amended for this project.

2.2.3.1 Need for Inclusion of Land Exchange in Document

Section 3003 of the NDAA directs the Forest Service to prepare a single EIS prior to the final execution of the land exchange to serve as the basis for all Federal decisions related to the proposed mine. The proposed action and action alternatives analyzed in detail in chapter 3 therefore assume that the land exchange would occur as directed by Congress; for this reason, it is included as a component common to all action alternatives (see section 2.2.2.1).

However, even though directed by Congress, the land exchange remains a discretionary decision on the part of Resolution Copper, which may or may not choose to undertake the exchange after receipt of the appraised value. It is possible that mining under the proposed action or action alternatives could also take place without the land exchange occurring. The single EIS must therefore allow for a comparison of potential impacts of mining that occurs on land remaining in Federal ownership with potential impacts that would occur following the land exchange. Whether the land exchange occurs or not, the mine would be developed in accordance with the Federal, State, and local laws governing mining operations. However, these laws could differ, depending on whether or not a land exchange occurred.

The no action alternative provides one baseline against which the proposed action and action alternatives may be compared. The no action alternative assumes no land exchange and no Forest Service approval of a GPO. This baseline allows a direct comparison of the effects of most of the mining impacts that would occur from the proposed action and action alternatives. However, the no action alternative is not sufficient to fully analyze the effects of the exchange of the selected lands.

Two other combinations of no action were considered during analysis:

- A fully executed land exchange, but no approval of the GPO; or

- The land exchange would not occur, Oak Flat would stay in Federal management, and the GPO would be approved with the mining taking place on public land.

The first combination was not carried forward as the Forest Service is unable to refuse approval of the GPO within their regulations and guidance. The second combination was considered because the land exchange is a discretionary action on the part of Resolution Copper. Therefore, an analysis was completed that compared the regulatory framework of mining activity on lands remaining in Federal ownership with the regulatory framework on lands being transferred to private ownership (appendix I). This provides the comparison of no land exchange, but approval of the mining plan of operations. See section 2.4 for more details. The effects of the land exchange are also assessed individually in each resource section of chapter 3.

2.2.4 Alternative 2 – Near West Proposed Action – Mine Plan Components

Alternative 2 – Near West Proposed Action would include approximately 9,789 acres of disturbance, of which 7,195 acres is NFS, 314 acres is ASLD managed, and 2,280 acres is private land.

Based on comments heard in scoping, in February 2018, Resolution Copper formally notified the Tonto National Forest that the company was revising its proposed action in the May 2016 version of the GPO and replacing the plan for an upstream-type tailings embankment at the GPO location with a modified centerline design, which would provide greater overall stability and a more robust design. This change was in response to public scoping comments and supported by internal engineering discussions at Resolution Copper. The revised centerline tailings embankment configuration is described in greater detail in section 2.2.4.2.

This followed Resolution Copper's July 2017 decision to relocate the process pond. The process pond was moved from NFS lands to private property at the West Plant Site to minimize adverse impacts on NFS surface resources. The process pond is further described in Appendix G, Further Details of East Plant Site, West Plant Site, MARRCO Corridor, and Filter Plant and Loadout Facility Infrastructure.

2.2.4.1 Water Use

This alternative is estimated to need about 590,000 acre-feet of groundwater pumped from the Desert Wellfield through the life of the mine (see appendix H).

2.2.4.2 Tailings Storage Facility and Tailings Pipeline Corridor

Approximately 1.37 billion tons of tailings produced by the mining operation would require storage in perpetuity. The proposed tailings storage facility location, as identified in the GPO, is on lands managed by the Tonto National Forest. The facility would be approximately 3 miles west of the West Plant Site (figure 2.2.4-1).

The GPO proposes a thickened tailings process. Thickening tailings involves the mechanical process of removing some water from the tailings slurry. Thickened tailings can have a solid content ranging from 50 to 70 percent, depending on the degree of thickening. Thickened tailings can be piped to a tailings storage facility and, because they are still a liquid, require storage in an impoundment contained by an embankment. The GPO indicates that the tailings slurry would be thickened to a solids content of approximately 50 to 65 percent for deposition in the impoundment. Overtime the tailings within the impoundment would settle and consolidate to a greater solids content.

NPAG and PAG tailings would be transported in the form of a thickened slurry from the concentrator complex at the West Plant Site to the tailings storage facility via two separate pipelines. To reduce potential water quality issues, PAG tailings would be placed using subaqueous deposition in such a way that they are kept saturated. This limits oxygen from interacting with the sulfides in the PAG tailings, minimizing and preventing water quality problems (e.g., acid rock drainage). The NPAG

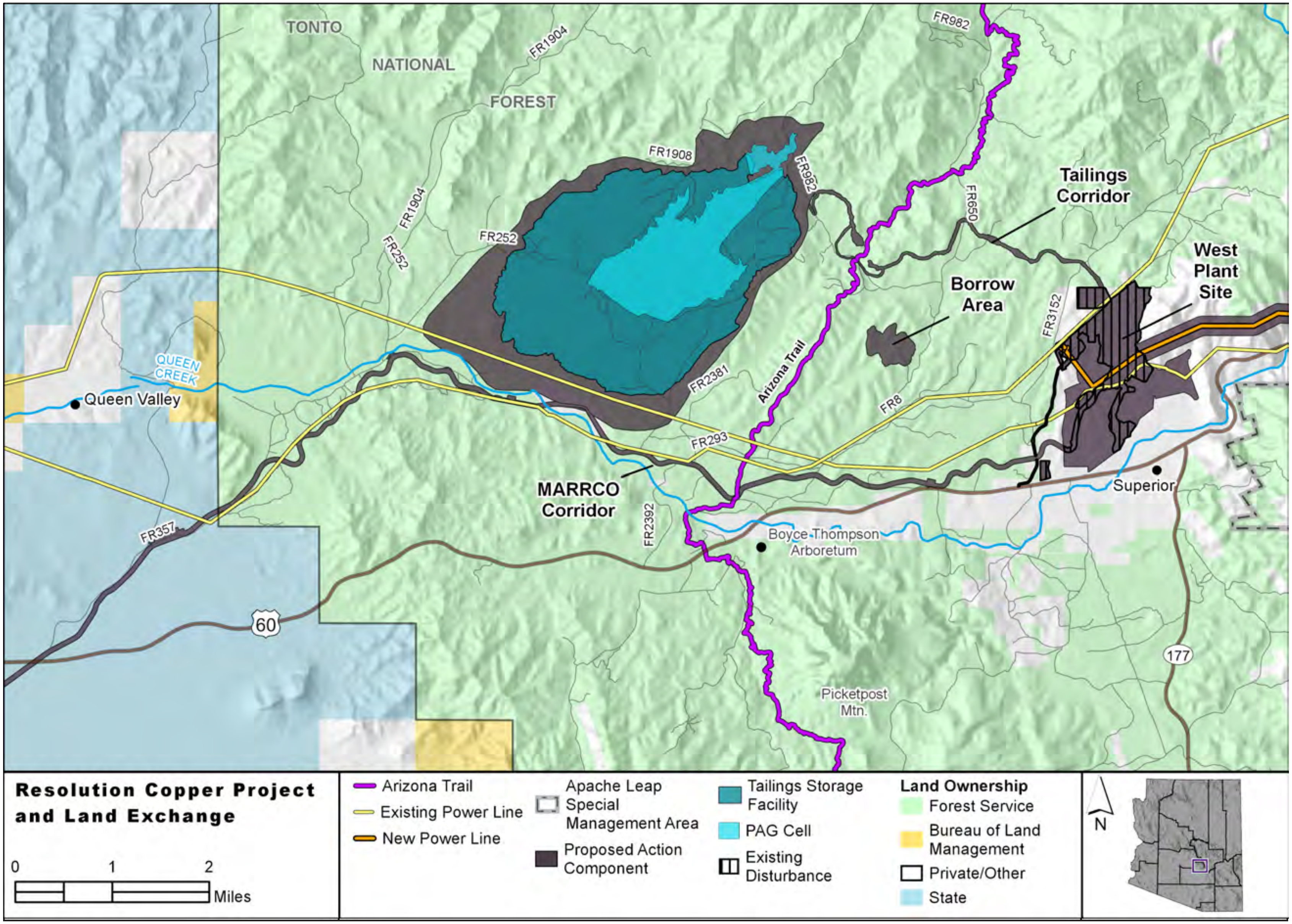


Figure 2.2.4-1. Overview of Alternative 2 – Near West Proposed Action tailings storage facility

would be deposited in a way that would eventually encapsulate the PAG tailings, allowing NPAG tailings to act as a buffer between PAG tailings and areas outside the tailings storage facility.

The modified proposed action tailings facility, Alternative 2 – Near West Proposed Action, would be constructed using a modified centerline embankment design rather than an upstream embankment, as Resolution Copper originally proposed in its GPO submitted to the Tonto National Forest on May 9, 2016. The GPO as amended responds to issues of public health and safety, as a modified centerline type embankment is considered more resilient than an upstream embankment, with less risk of failure. The modified centerline embankment would be constructed from compacted and free-draining cyclone tailings sand and earthen fill. NPAG tailings are processed through hydrocyclones[17] to produce a coarse particle tailings stream (cyclone sand used for construction) and a finer particle tailings stream. The larger tailings particles would drain water freely and would be mechanically compacted during embankment construction to further increase the stability of the embankment. The finer materials would be deposited into the interior of the tailings facility, where they would provide a low-permeability zone between the PAG tailings and the higher permeability perimeter embankment. As the tailings storage facility grows over time, the embankment would progressively be elevated to contain the tailings. A general schematic of the modified centerline design is shown in figure 2.2.4-2. Resolution Copper currently is proposing an overall 4H:1V slope design for the embankment.

Portions of the embankment may be modified to a 3H:1V design to

- reduce the overall amount of cycloned sands required, and
- facilitate an earlier start to concurrent reclamation activities on the embankment (at approximately mine life year 22 vs. year 28 for the 4H:1V design).[18]

Auxiliary facilities within the tailings storage facility would include a perimeter fence, private roads, borrow areas, soil stockpile areas, seepage control facilities, diversion channels and seepage containment ponds, groundwater monitoring wells, an office, and an equipment maintenance facility (figure 2.2.4-3).

The tailings facility would include a recycling system and a seepage containment system and stormwater diversions to control tailings seepage and surface runoff. All slurry tailings facilities have a pond on the surface known as the “recycled water pond.” The water collected in the recycled water pond would be recycled and pumped to the mill for reuse in ore processing via an aboveground pipe within the tailings conveyance corridor.

While water is recycled through the recycled water pond, some water also remains within the tailings void space and most of this water would eventually either drain downward or remain entrained within the tailings. The seepage and stormwater containment system would consist of engineered low-permeability layers, cutoff walls, grout curtains, diversion channels, and internal drains directing seepage and runoff to 11 planned downstream collection ponds. The NPAG embankment would contain an underdrain system comprising sand and gravel blanket and finger drains (primarily along main drainages, with some extended beneath the tailings beach) to maintain a low water level in the tailings embankment and to intercept and direct seepage from the impoundment to the downstream seepage collection system ponds.

During facility development, a PAG tailings starter cell would be constructed to maintain pyrite tailings saturation throughout the process and to limit seepage. This would include construction of a separate, earthfill starter dam to contain the initial PAG deposits; this starter dam would be constructed for the first 9 years of PAG tailings and would be lined with an engineered low-permeability layer. A combination of additional seepage collection design features would be implemented

17. Hydrocyclone is a device to classify, separate, or sort particles in a liquid suspension based on particle size and particle density.

18. The specific preferred design may be determined during the NEPA process or may be optimized if and when Alternative 2 becomes the selected alternative in the ROD.

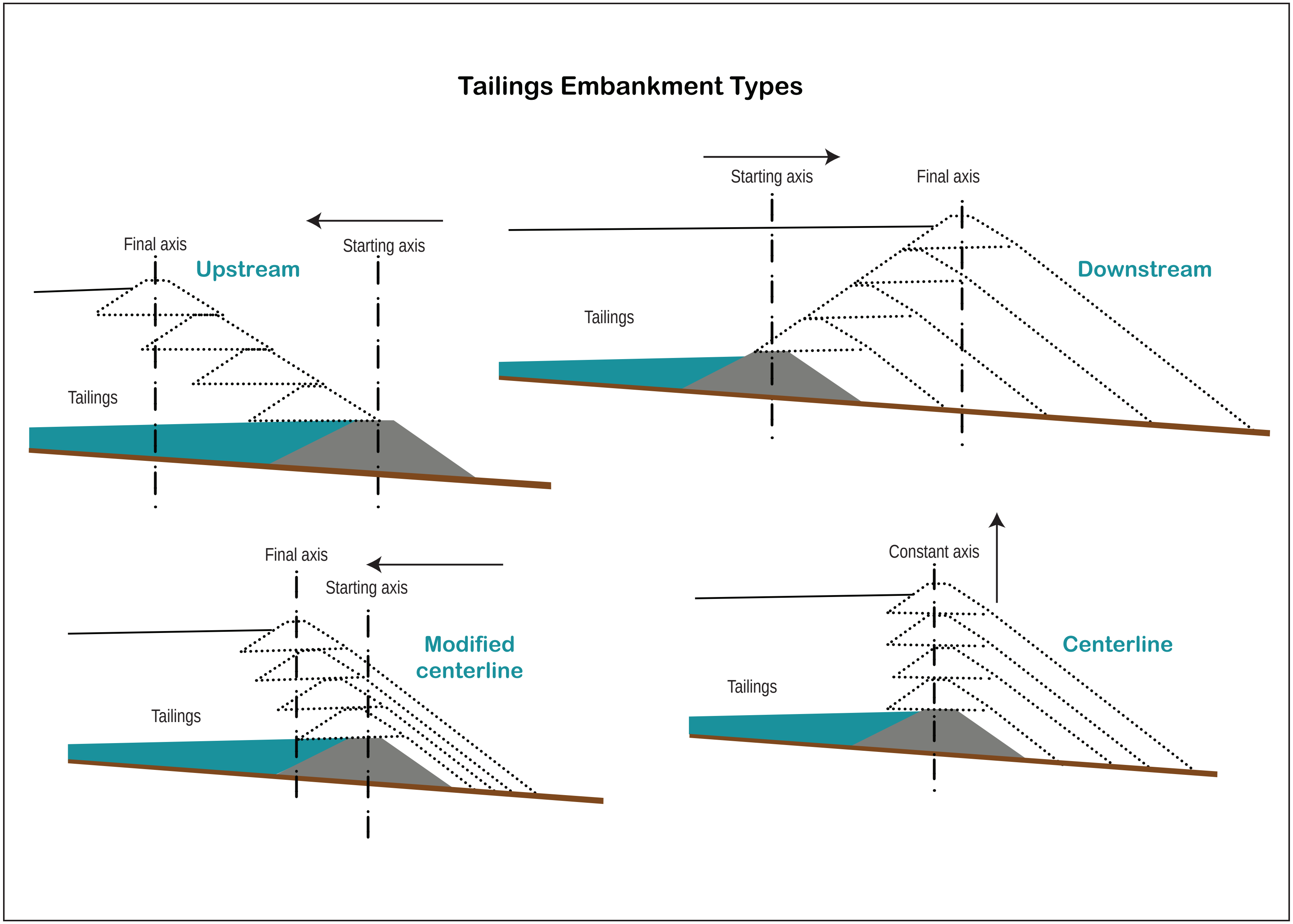


Figure 2.2.4-2. Diagram illustrating various embankment designs

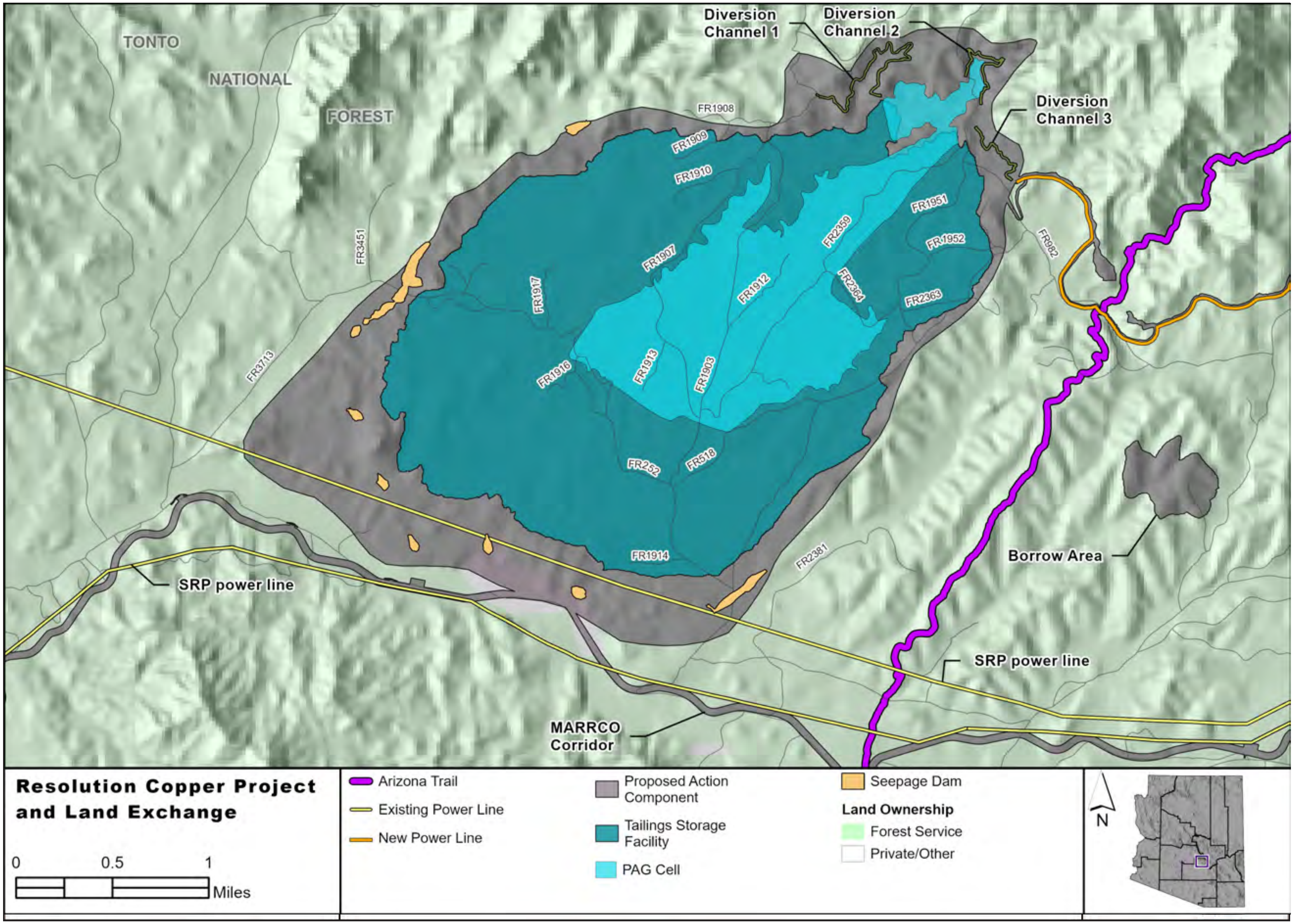


Figure 2.2.4-3. Alternative 2 – Near West Proposed Action tailings storage facility detailed layout

to limit seepage; these may include additional selective placement of engineered low-permeability layers, additional seepage collection dams, lined seepage collection ponds, pumpback systems, and refined stormwater control systems. The exact selection and placement of these features is, at present, still being optimized and would be finalized toward the end of the environmental impact assessment process.[19]

A 34.5-kV tailings substation would be constructed near the offices and maintenance facilities and would receive electricity via a 34.5-kV transmission line from the West Plant Site substation.

The GPO identified four borrow areas, all located on NFS lands, that have been targeted for different borrow requirements (i.e., earthfill material for the starter dams and embankments, gravel for blanket underdrains, riprap for erosion control, and soil cover for reclamation). Three of these borrow areas were within the tailings storage facility, and one is located outside the tailings storage facility footprint (see figure 2.2.4-1). However, Resolution Copper recently determined that borrow areas within the proposed tailings footprint would provide adequate volumes of earthfill material.

If needed, material processing plants would be mobile and move to locations within the tailings footprint where borrow material is needed. Borrow material would be used for concurrent reclamation of the tailings storage facility.

The tailings storage facility would be accessible at three locations:

- via a service road adjacent to the tailings pipeline corridor,
- from Hewitt Canyon Road (NFS Road 357), and
- from NFS Road 8.

During tailings storage facility construction, Hewitt Canyon Road and NFS Road 8 would be used by mine construction vehicles/equipment and provide emergency access. Several existing NFS roads within the proposed tailings storage facility would be removed from public access (see the "Transportation and Access" resource section in chapter 3). Several of these NFS roads would be reconstructed to provide access for mine equipment. A separate service road would be constructed around the periphery of the tailings storage facility for access to power distribution, seepage collection ponds, and pumps.

Throughout construction of the tailings facilities, sand and gravels at the tailings site facility would be salvaged and stored at a soil salvage yard for use during construction of the tailings facility and reclamation of the tailings facilities. Upon closure in mine year 46, the total footprint of the tailings storage facility would be approximately 4,909 acres. The tailings structure would be a four-sided perimeter embankment dam with an ultimate crest elevation of 2,751 feet above mean sea level (amsl). Maximum embankment height would be on the southern embankment at approximately 520 feet, with a 4:1 exterior slope angle.

Table 2.2.4-1 summarizes the components of the proposed action tailings storage facility.

2.2.4.3 Closure and Reclamation

The closure and reclamation phase would occur after the 40-year operations phase and would have a duration of approximately 5 to 10

19. The technical documents prepared by Resolution Copper describe a phased approach to seepage control. Level 1 seepage control consists of foundation treatments and barrier layers built into the facility and the 11 initial seepage collection ponds downstream. Level 1 seepage controls would be installed as part of the initial construction. Level 2, 3, and 4 seepage controls were considered in the design to further control seepage. Some of these controls would have to be built into the facility from the start (such as any low-permeability liners), while others would be implemented if real-world observations during operations indicate that seepage controls are not operating as anticipated. The seepage analysis in section 3.7.2 contains further descriptions of these controls and how they were incorporated into the analysis (Klohn Crippen Berger Ltd. 2019d).

Table 2.2.4-1. Summary of Alternative 2 – Near West Proposed Action tailings storage facility

Tailings Storage Facility	Description
Location	3 miles west of the West Plant Site, north of Hewitt Canyon Road (NFS Road 357)
Land ownership	Forest Service
Distance from West Plant Site	3 miles
Tailings type and disposal	Thickened slurry tailings placed subaqueously for PAG tailings from barge, NPAG placed hydraulically from perimeter At disposal, PAG tailings would be 50% solids content; thickened cyclone overflow (NPAG) would be 50% solids content; and NPAG sent directly from the mill would be 65% solids content. See figure 2.2.2-10 for more information on tailings solids content range.
Tailings embankment	Cycloned tailings and earthen starter dam, raised with compacted cyclone sand in a modified centerline construction approach with a 4H:1V slope
Lining and other seepage controls	Engineered, low-permeability layers would be installed prior to start-up. These would be located within the PAG cell starter dam facility and in areas where the foundation may have high permeability. Seepage from the tailings would be recovered in 11 seepage collection ponds downstream of the embankment. The seepage and stormwater collected at the collection ponds would be managed during operations for use in the process water system. Finger and blanket drains would underlie the embankment and part of the NPAG tailings.
Approximate size at fence line of tailings storage facility	4,909 acres
Approximate embankment height	521 feet
Tailings pipelines / conveyance	Thickened slurry pumped in two streams (PAG and NPAG) to the tailings storage facility and recycled water pipeline to return water to processing loop at West Plant Site 5.33 miles of corridor from West Plant Site to tailings storage facility
Auxiliary facilities	Two clusters of 26 cyclones, two high-density thickeners Upstream surface water north, west, and east of the tailings storage facility would be diverted to the extent possible around the facility through constructed diversion channels. This non-contact water would be diverted downstream to Queen Creek.
Other design considerations	The Arizona National Scenic Trail would need to be crossed by the slurry pipeline corridor and associated access road, but not rerouted. 8 miles of NFS roads are expected to be decommissioned or lost.
Closure and reclamation	Concurrent reclamation of tailings facility beginning approximately at mine year 22 or at mine year 28, depending on final slope design, would occur on the modified centerline tailings embankment. Closure of the tailings recycled water pond is estimated to take up to 25 years after the end of operations. Until that time, excess seepage in seepage ponds would be pumped back to the recycled water pond, and reclamation would take place on the embankment and tailings beaches. After the recycled water pond is closed, seepage ponds would be enlarged to allow adequate evaporation of seepage, and the remaining reclamation of the tailings would occur.

years.[20] A specific time frame for the closure and reclamation phase would not be known until after a final GPO is submitted to the Tonto National Forest and approved. The GPO describes the preliminary closure and reclamation plans that would occur at each of the main facilities and the linear features that connect them, as summarized in this chapter. The primary goals of reclamation are to

- stabilize areas of surface disturbance;
- prepare those areas for a post-mining land use that is compatible with surrounding uses; and
- ensure long-term protection of the surrounding land, water, and air resources.

General Reclamation Procedures and Schedule

Although closure and reclamation would be a distinct phase after the operations phase during which the majority of the reclamation efforts would occur, the proposed action would employ three schedules of reclamation throughout the life of the mine: interim, concurrent, and final reclamation. Interim and concurrent would be the same as described in Section 2.2.2.2, General Plan of Operations Components.

FINAL RECLAMATION

Final reclamation efforts would occur for a duration of 5 to 10 years after the operations phase as described in Section 2.2.2.2, General Plan of Operations Components.

The final reclamation efforts that would occur at each of the main facilities are described next.

TAILINGS STORAGE FACILITY CLOSURE AND RECLAMATION

In the final years of operations, tailings would be deposited to promote surface water runoff to the north, where runoff would be directed downstream, diverting around the seepage collection ponds, and surfaces throughout the facility would be reshaped as necessary to eliminate any potential for standing water.

A layer of NPAG tailings would be deposited over the PAG tailings as the recycled water pond disappears, in order to continue to isolate the PAG tailings from oxygen. During this time, the embankment and dry tailings beach areas would be reclaimed, with the PAG tailings with the NPAG cover being reclaimed last and covered by a 1- to 2-foot layer of low-permeability, erosion-resistant soil (e.g., Gila conglomerate or equivalent soil, sand, and gravel mix) and revegetated. The timing of reclamation is dependent on the surface being dry enough to allow equipment access for reclamation.

Estimated seepage rates suggest passive closure of the tailings facility may be difficult, and active management may be required up to 100 years after the end of operations. Up to 25 years after closure, excess seepage would be pumped back to the recycled water pond. After 25 years, the recycled water pond is closed, and the seepage ponds would be enlarged to allow for more evaporation. Any excess seepage beyond the evaporation capacity of the seepage collection ponds would need to be actively treated. The sludge containing concentrated metals and salts from evaporation would require cleanup and handling as a solid or hazardous waste.

20. Note that the time required to achieve final reclamation is dependent on how long it takes for the tailings to drain and become accessible, as well as how long seepage from the tailings facility is required to be actively managed. Therefore, reclamation timing varies between alternatives.

2.2.5 Alternative 3 – Near West – Ultrathickened

Alternative 3 – Near West – Ultrathickened would include approximately 9,789 acres of disturbance, of which 7,195 acres is NFS, 314 acres is ASLD managed, and 2,280 acres is private land.

Alternative 3 is a modification of the tailings facility but remaining in the same location as Alternative 2. Alternative 3 was developed to respond to issues of public health and safety and groundwater quality. It addresses these issues by changing the techniques used in the tailings storage facility to reduce potential for seepage and exposure of PAG tailings. This action alternative would not change any plan components described under the proposed action, except for those associated with the tailings storage facility and tailings disposal. East Plant Site infrastructure, panel cave mining, West Plant Site ore processing, slurry copper concentrate delivery to the filter plant, and other utility corridors would remain identical to the proposed action (figure 2.2.5-1).

Alternative modifications to the proposed GPO tailings facility (figure 2.2.5-2) include the following:

- construction of two separate cells within the tailings facility: one for the NPAG and one for PAG tailings (PAG tailings would be kept saturated to prevent oxidation), separated by an internal splitter berm, in order to better control water quality concerns associated with PAG tailings (see figure 2.2.2-12);
- inclusion of engineered low-permeability layers in the PAG tailings cell to limit seepage and maintain PAG tailings saturation, to better control water quality concerns associated with PAG tailings; and
- incorporating further thickening into the NPAG tailings processing prior to deposition in the impoundment (further increasing the solids to water content of the tailings, from 50 to 65 percent in Alternative 2, up to 62 to 70 percent in Alternative 3), in order to reduce the amount of seepage from the NPAG tailings.

The rationale for choosing this alternative for assessment in the EIS is that, compared with the proposed action, it would allow for a direct comparison of the impacts from further thickening and segregating the saturated PAG tailings in an engineered low-permeability layered cell. By contrast, Alternative 2 only uses a separate engineered low-permeability layered PAG tailings cell during the first 9 years of operation and is not optimally located over less-fractured bedrock.

2.2.5.1 Alternative 3 Mine Plan Components

Water Use

This alternative uses the least water of the four conventional tailings alternatives (Alternatives 2, 3, 5, and 6) and is estimated to need about 490,000 acre-feet of groundwater pumped from the Desert Wellfield through the life of the mine (see appendix H). This is about 17 percent less water than the alternative without additional thickening of the NPAG tailings (Alternative 2), primarily as a result of greater recovery of water from the tailings and less evaporation losses from deposited tailings.

Tailings Facility – Tailings Type

The modified proposed action includes a slurry tailings disposal method, with the tailings split into a wet slurry of approximately 84 percent NPAG and 16 percent PAG tailings by total volume. The PAG tailings would be thickened at the West Plant Site to approximately 50 percent solids content and the NPAG tailings to approximately 65 percent solids. The cyclone overflow of the NPAG tailings would be thickened at the tailings storage facility site prior to depositing into the impoundment. Under this alternative both the NPAG tailings and cyclone overflow which is deposited in the impoundment would be high-density thickened at the tailings storage facility site to a higher solids content in comparison to Alternative 2 (NPAG thickened to 70 percent; cyclone overflow of the NPAG tailings thickened to 62 percent).

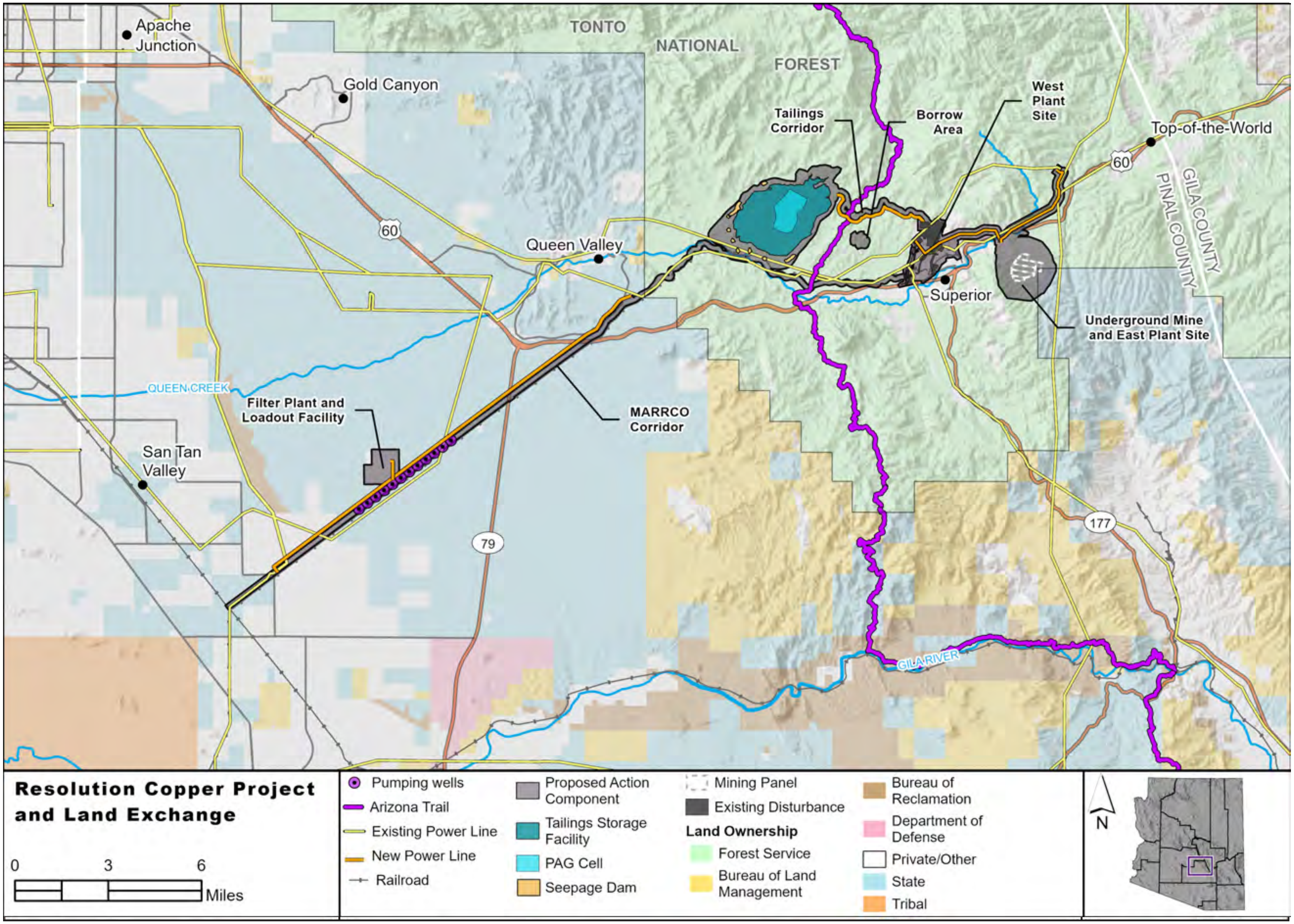


Figure 2.2.5-1. Alternative 3 – Near West – Ultrathickened overview

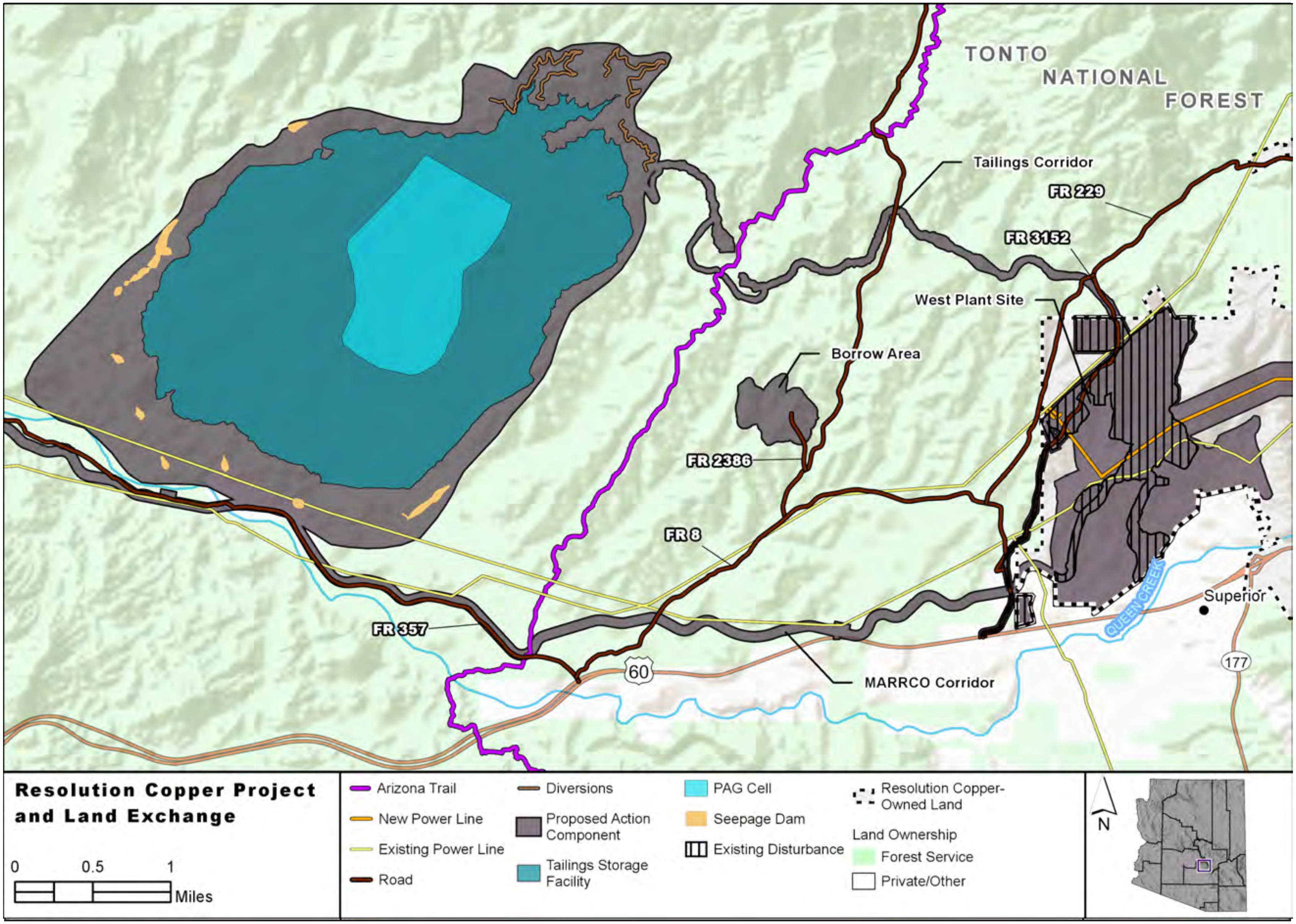


Figure 2.2.5-2. Alternative 3 – Near West – Ultrathickened tailings storage facility

Tailings Facility – Tailings Conveyance

Tailings conveyance via pipeline to the modified proposed action tailings facility would be the same as described in Alternative 2 – Near West Proposed Action.

Tailings Facility – Embankment Type

Alternative 3 would use the same approach, including an earthen starter dam, raised with compacted cyclone sand in a modified centerline construction; however, the downstream slope would be 3H:1. Borrow material would come from the same locations as described in Alternative 2. The PAG tailings cell would be located within the larger NPAG deposit, separated by a splitter berm construction of compacted cycloned sand.

Tailings Facility – Liner

Where NPAG tailings are deposited on potentially high-permeability bedrock, the foundation would be covered with an engineered, low-permeability layers prior to tailings deposition. The PAG tailings cell would be hydraulically contained by engineered, low-permeability layers and deposited over less-fractured bedrock.

Alternative 3 would make use of the same phased approach for control and collection of seepage as Alternative 2, including downstream seepage collection ponds, and additional grouting, collection ponds, or pumping wells if needed.

Tailings Facility – Disposal Method

The PAG tailings would be sent directly to a floating deposition barge for subaqueous deposition located within the PAG cell. The difference to apply high-density thickening of the NPAG tailings would occur prior to placement within the tailings storage facility to further reduce entrained water through evaporation and thereby reduce seepage. There is a potential for even more water to be removed from the tailings through "thin-lift" deposition techniques (depositing tailings in very thin layers), which would be used if found to be feasible with ultrathickened tailings.

The PAG tailings would be maintained in a saturated condition under a water cover at least 10 feet deep throughout operations. A primary difference between Alternatives 2 and 3 is the location of the recycled water pond. Under Alternative 2 the recycled water pond overlies both a portion of the NPAG and all of the PAG tailings, while under Alternative 3 the recycled water pond would only overlie the PAG tailings cell. Low spots that accumulate water, released from the tailings or stormwater on the NPAG tailings surface, would be pumped and the water would be directed to the PAG tailings cell.

Tailings Facility – Auxiliary Facilities

Access roads and other auxiliary facilities associated with Alternative 3 are similar to those described in section 2.2.4. Stormwater diversion channels would be needed to route upstream storm flows around the facility. Precipitation falling within the facility would be incorporated into the tailings reclaim water. Additional cyclone thickeners would be required to thicken the NPAG tailings to a greater percentage than Alternative 2.

Tailings Facility – Closure and Reclamation

During operations, the cycloned sand embankment slopes would be progressively reclaimed as facility development allowed (i.e., lower slopes would be reclaimed as subsequent lifts added). Channels and other features would be constructed at strategic locations on the closed embankment slopes to convey stormwater away from the facility and seepage ponds, and the slopes would be progressively covered with a low-permeability, erosion-resistant soil layer (e.g., Gila conglomerate) and revegetated.

In the final years of operations, tailings would be deposited to promote surface water runoff to the north, where runoff would then be directed downstream, diverting around the seepage collection ponds, and surfaces

throughout the facility would be reshaped as necessary to eliminate any potential for standing water.

Following closure, the recycled water pond within the PAG cell would gradually be reduced in size and the seepage ponds downstream would be enlarged in order to maximize evaporation. The PAG cell would then be covered with a layer of NPAG tailings topped by a 1- to 2-foot layer of low-permeability, erosion-resistant soil (e.g., Gila conglomerate or equivalent soil, sand, and gravel mix) and revegetated. The remaining NPAG areas would similarly be covered by a 1- to 2-foot layer of low-permeability, erosion-resistant soil (e.g., Gila conglomerate or equivalent soil, sand, and gravel mix) and revegetated. The reclamation timing is dependent on the surface being dry enough to allow equipment access.

Active closure would be required for up to 9 years after the end of operations. Any water collected in the seepage collection ponds beyond the evaporation capacity of the seepage collection ponds would need to be actively treated. The sludge containing concentrated metals and salts from evaporation would require cleanup and handling as a solid or hazardous waste.

Other closure and reclamation measures, such as the removal of buildings, pipelines, electrical equipment and electrical lines, and the recontouring and revegetation of parking areas and other areas of ground disturbance, would be substantially identical to those described for Alternative 2.

Table 2.2.5-1 summarizes the components of the Alternative 3 tailings storage facility.

Table 2.2.5-1. Summary of Alternative 3 – Near West – Ultrathickened tailings storage facility

Tailings Storage Facility	Description
Location	3 miles west of the West Plant Site, north of Hewitt Canyon Road (NFS Road 357); same as Alternative 2 – Near West Proposed Action
Land ownership	NFS
Distance from West Plant Site	3 miles
Tailings type and disposal	Thickened slurry tailings placed subaqueously for PAG tailings from barge, NPAG placed hydraulically from perimeter At disposal—PAG tailings would be 50% solids content; thickened cyclone overflow (NPAG) would be 62% solids content; and additionally thickened NPAG stream sent directly from the mill would be 70% solids content.
Tailings embankment	Cycloned tailings and earthen starter dam, raised with compacted cyclone sand in a modified centerline construction approach with a 3H:1V slope
Lining and other seepage controls	Engineered, low-permeability layers would be installed prior to start-up. These would include the entire PAG cell and in other areas where the foundation may have high permeability. Seepage from the tailings would be recovered in 11 seepage collection ponds downstream of the embankment. The seepage and stormwater collected at the collection ponds would be managed during operations for use in the process water system. Finger and blanket drains would underlie the embankment and part of the NPAG tailings
Approximate size at fence line of tailings storage facility	4,909 acres
Approximate embankment height	510 feet
Tailings pipelines / conveyance	Thickened slurry pumped in two streams (PAG and NPAG) to the tailings storage facility and recycled water pipeline to return water to processing loop at West Plant Site 5.33 miles of corridor from West Plant Site to tailings storage facility
Auxiliary facilities	Two clusters of 26 cyclones, two high-density thickeners Upstream surface water north, west, and east of the tailings storage facility would be diverted to the extent possible around the facility through constructed diversion channels. This non-contact water would be diverted downstream to Queen Creek.
Other design considerations	8 miles of NFS roads are expected to be decommissioned or lost. Arizona Trail would need to be crossed by the slurry pipeline corridor and associated access road, but not rerouted.
Closure and reclamation	Reclamation of the tailings embankment face would occur progressively until about mine year 30 and continue through the end of the mining operations (approximately mine year 46). Dewatering of the tailings recycled water pond is estimated to take up to 5 years after the end of operations. Until that time, excess water collected in seepage ponds would be pumped back to recycled water pond, and reclamation would take place on the embankment and tailings beaches. After the recycled water pond is closed, seepage ponds would be enlarged to allow adequate evaporation of pond inflows, and the remaining reclamation of the tailings would occur.

2.2.6 Alternative 4 – Silver King

Alternative 4 – Silver King would include approximately 10,617 acres of disturbance of which 7,949 acres is NFS, 314 acres is ASLD managed, and 2,354 acres is private land.

The Silver King alternative was developed to respond to issues of water use, air quality, public health and safety, and groundwater quality through the use of filtered tailings instead of thickened slurry tailings (as proposed in the GPO) at an alternative location on Tonto National Forest land in an area known as Silver King. This alternative includes changes to the GPO for the tailings location, tailings processing and storage method, the location of the filter plant and loadout facility, and other emergency storage ponds which would increase the West Plant Site footprint and require different access road realignment along Silver King Mine Road, compared with the GPO and Alternatives 2, 3, 5, and 6. Other plan components of the GPO remain the same as described in Alternative 2 – Near West Proposed Action.

This tailings facility would occupy the lower end of Silver King Canyon, in the Silver King Wash, the lower portion of Whitford Canyon, and Peachville Tank, immediately adjacent to the West Plant Site north of Superior, Arizona (figure 2.2.6-1). The tailings footprint was designed to avoid existing mining operations at the Silver King Mine and a historic cemetery; however, 5.5 miles of the Arizona National Scenic Trail (Arizona Trail) would need to be rerouted and the McGinnel claim, 0.5 mile north of Silver King Mine, would be within the footprint of the tailings pile. Although the conceptual design of this facility is quite high (1,040 feet), the facility would consist of several benches to follow and mimic existing topography.

The use of filtered tailings reduces some concerns with water quality and public safety because removing water from the slurry prior to placement decreases the mobility of the tailings, providing greater stability of these tailings and a substantial reduction in seepage. Filtered tailings would allow progressive reclamation and compaction, but this alternative has large, dry, exposed surfaces that need to be managed to avoid air quality concerns. At this time, filtered tailings have not been used on a facility with a production rate as high as that proposed by Resolution Copper.

Tailings slurry would be delivered in separate tailings pipelines to two filter plants at the Silver King facility (one for PAG and one for NPAG) and filtering would then occur to remove water from the tailings, increasing percent solids generally to about 86 to 89 percent (vs. approximately 50 to 65 percent in the GPO tailings plan). Once filtered, the tailings would be conveyed into place as solids rather than pumped as a semi-liquid in a tailings pipeline, and, once in place, would be compacted in place using earthmoving equipment. The NPAG and PAG filtered tailings would be stacked in separate but nearly adjacent facilities.

Surface water management would include large upstream diversion dams with high-capacity outlets as well as large downstream collection ponds, as there would be no water recycling ponds, compared with slurry facilities to handle contact water. Emergency slurry ponds would be required for temporary storage of slurry in event of a tailings filter plant shutdown.

The rationale for choosing this alternative for detailed analysis is that, compared with the proposed action, it allows for a comparison of the impacts of thickened slurry tailings vs. filtered tailings, and it allows a comparison regarding whether the specific location selected for tailings in the GPO is preferable to other locations in the same general vicinity of Superior.

2.2.6.1 Alternative 4 Mine Plan Components

Relocation of Filter Plant and Loadout Facility

This alternative would relocate the filter plant and loadout facility from the proposed location near Magma Junction to the West Plant Site, near the concentrator on the existing rail line north of U.S. Route 60 (U.S. 60) (figure 2.2.6-2). This modification to the proposed action responds to issues of air quality, noise, and public health and safety associated with locating mining support facilities in the heavily populated East Salt River valley.

The filter plant and loadout facility would continue to pressure-filter the copper concentrate in a way that is similar to the proposed process

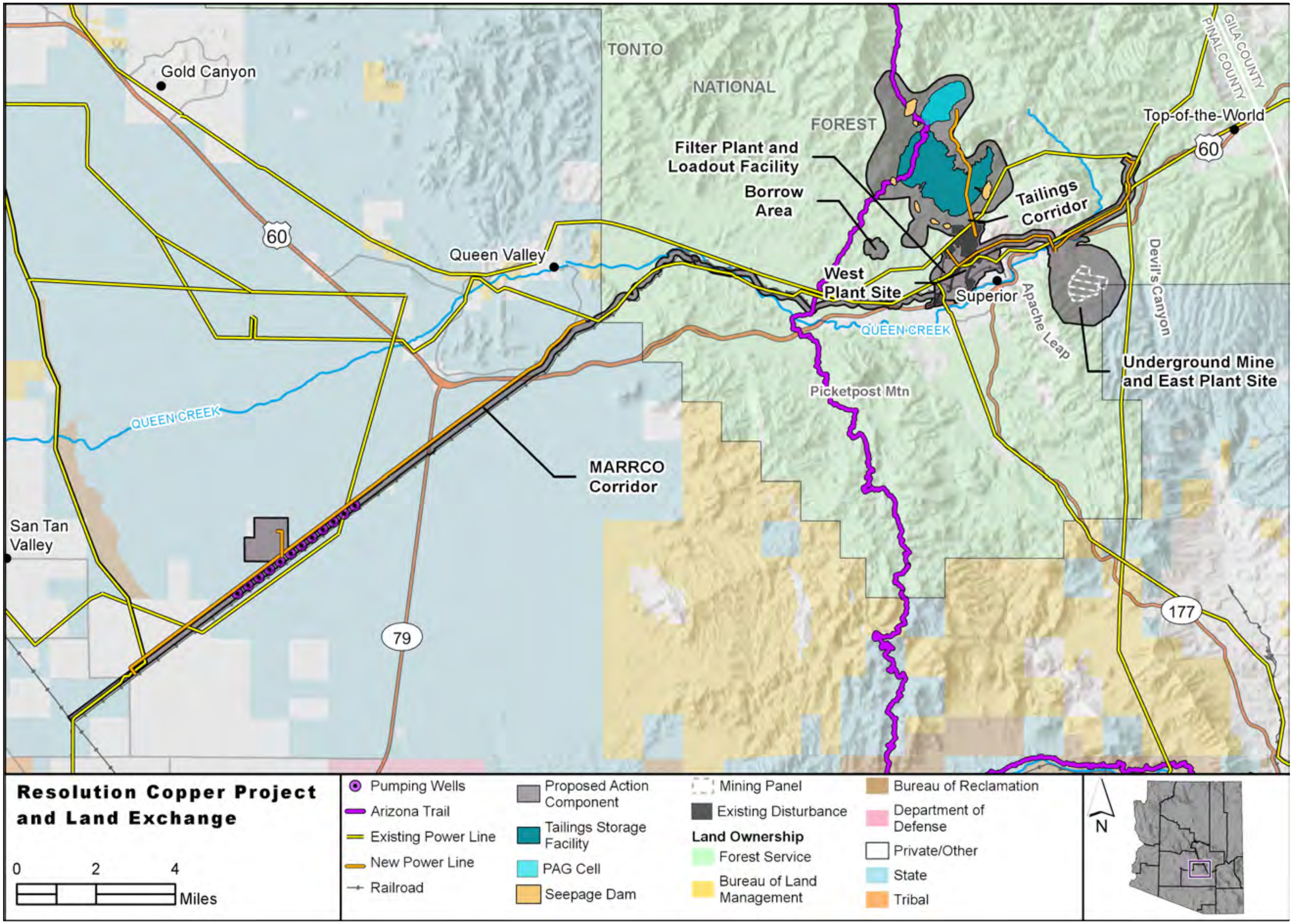


Figure 2.2.6-1. Alternative 4 – Silver King overview

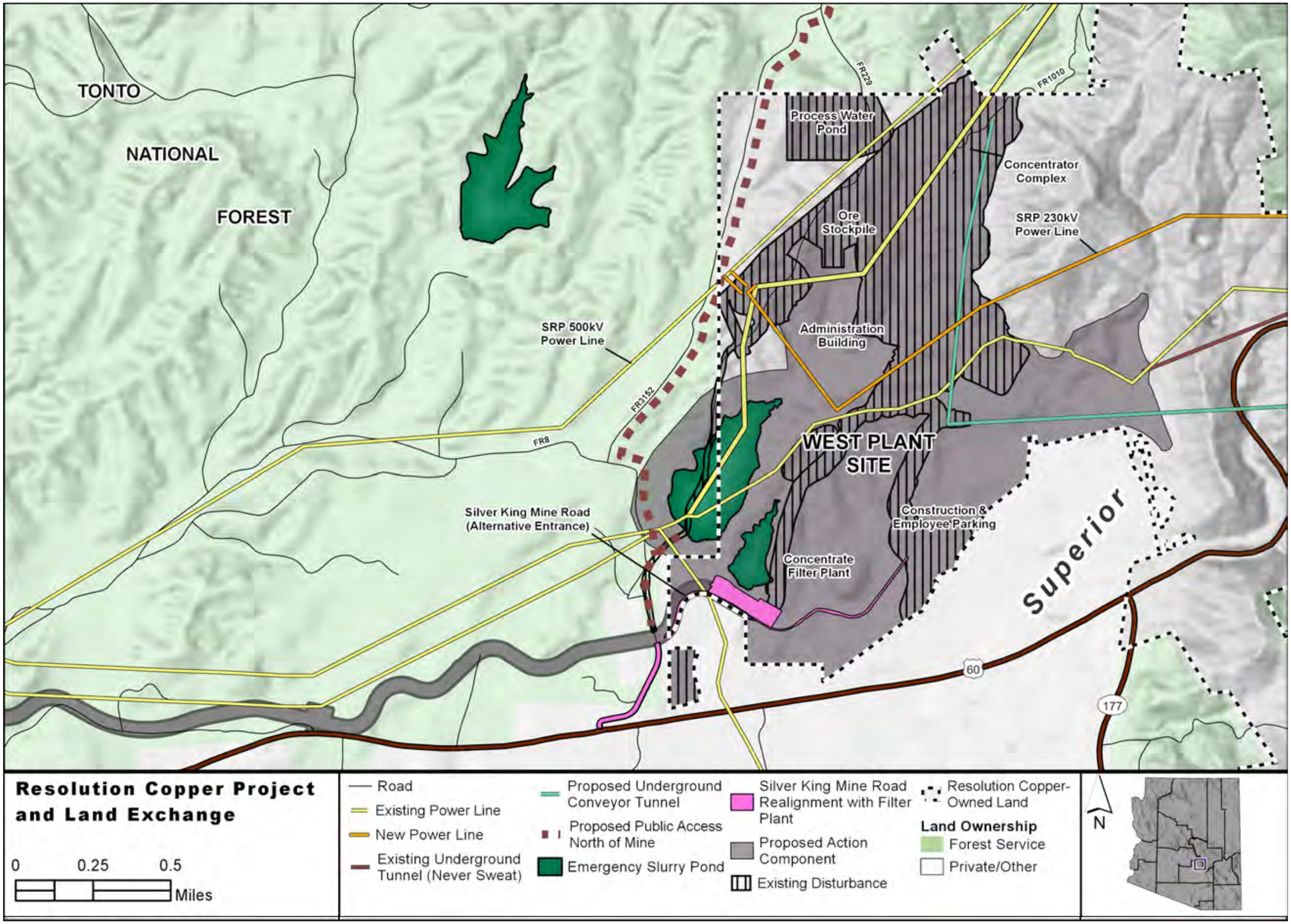


Figure 2.2.6-2. Relocation of filter plant and loadout facility

described in the GPO. Pipelines for copper concentrate and filtrate water would be located within the West Plant Site and not within the MARRCO corridor, thereby eliminating 21 miles of concentrate pipelines. This responds to issues of water quality and public health and safety that may be associated with concentrate pipeline ruptures or spills.

Two 50-railcar trains would instead use the MARRCO corridor twice a day to transport copper concentrate to market (concentrate loads would be transferred at Magma Junction to container cars of the Union Pacific Railroad for transport to an off-site smelter). The MARRCO corridor track would require upgrades along the entire length, bridge replacement at Queen Creek Bridge, and significant upgrades for crossings at Queen Creek, U.S. 60, State Route (SR) 79, the Arizona Trail, Hewitt Canyon Road, and other NFS roads. Except for the removal of concentrate pipelines, the dimensions and uses of water pipelines, groundwater wells, pump stations, and 69- and 12-kV power lines within the MARRCO corridor would remain unchanged from how these facilities are described in the GPO.

Water Use

This alternative uses the least amount of water of all the tailings alternatives and is estimated to need about 180,000 acre-feet of makeup water pumped from the Desert Wellfield through the life of the mine (see appendix H). This is about 65 percent less water than Alternative 2, due to recovery of water during filtering and subsequently less evaporative loss from the tailings beaches and recycled water pond.

Tailings Facility – Tailings Type

NPAG and PAG tailings streams would each undergo dewatering to a "filtered" tailings type. Filtering tailings would remove more water from the tailings slurry and result in filtered tailings with approximately 86 to 89 percent solids. At this moisture content, the tailings are referred to as a "dry cake" and must be transported by conveyor or truck to a filtered tailings storage facility. This modification responds to issues of public health and safety, water quality, and water use by removing water from the tailings. The filtered tailings can be placed and compacted into piles and have less water entrained in the tailings facility (figure 2.2.6-3).

Tailings Facility – Tailings Conveyance

Tailings slurry would be delivered by pipeline from the West Plant Site to the two separate Silver King filter plants, one located on higher ground above and adjacent to the NPAG facility approximately 1.5 miles north of the West Plant Site, and the other on higher ground above and adjacent to the PAG facility approximately 1.4 miles north-northwest of the NPAG site. Situating the filter plants on higher ground would allow for greater efficiency through downhill conveyance of the two types of filtered tailings to their respective storage facilities. Upon arriving at each filter plant, the NPAG and PAG tailings slurries would be pressure filtered to remove water, then subsequently handled as solids and delivered by conveyor and mechanically placed within each of the two tailings facilities.

Unlike a typical slurry tailings facility, where slurry can be emptied directly into the facility in the event of a processing halt, for filtered tailings, one or more emergency slurry storage ponds would be constructed close to the West Plant Site as emergency disposal location(s) for filtered tailings in the event that a filter plant temporarily stops processing. The emergency storage facilities would be constructed behind earthfill embankment(s) and would be lined.

Tailings Facility – Embankment Type

Filtered tailings are treated as solids (not liquids) and therefore do not require storage behind an embankment. No embankment would be required for construction of the Silver King alternative tailings storage facility; however, a compacted zone of tailings around the perimeter of the facility would provide structural support.

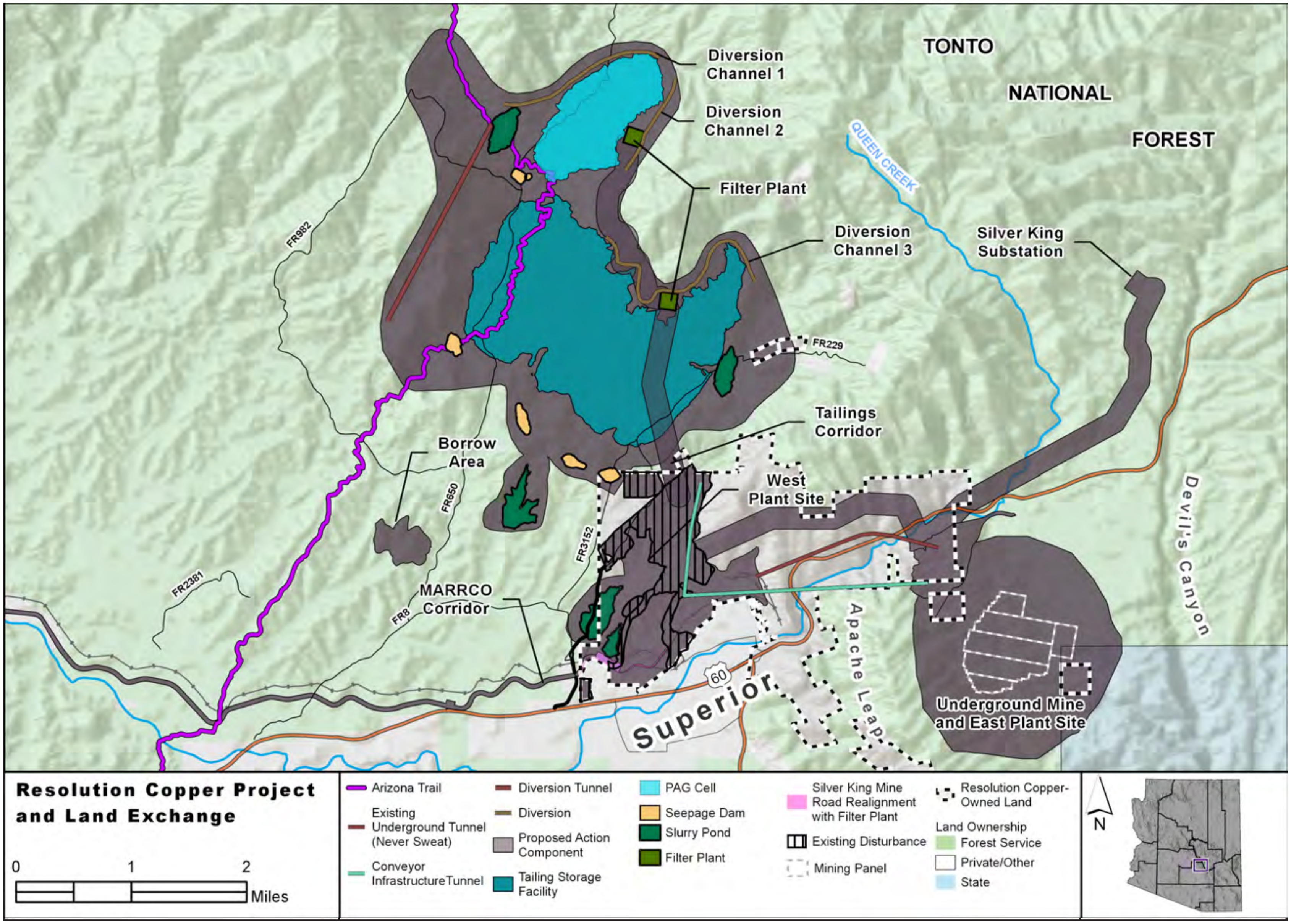


Figure 2.2.6-3. Alternative 4 – Silver King tailings storage facility

Tailings Facility – Liner

The Silver King alternative tailings storage facility would not be lined. As discussed further in section 3.7.2, the use of a full liner was considered during alternatives development and eventually dismissed from detailed consideration due to logistical concerns.

Tailings Facility – Disposal Method

Tailings would be placed using “trains,” which are mechanical conveyors that place tailings in rows. Additional mobile mechanized equipment would be used to spread and compact the tailings. As stated previously, there would be two separate filtered tailings facilities: the NPAG tailings would be stacked closer to the West Plant Site and the PAG tailings farther north and upstream of the NPAG facility. Maintaining two separate facilities provides flexibility in how PAG tailings are managed and reclaimed.

Tailings Facility – Auxiliary Facilities

Unlike a slurry tailings facility, in which precipitation falling on the tailings is directed to the recycled water pond, stormwater must be managed on filtered facilities to prevent ponding on the surface of the tailings. Stormwater diversion channels, diversion tunnels, and retention structures would be needed to divert stormwater runoff from the tailings piles or move runoff quickly off of the facilities. During operations, the tailings surfaces would be sloped to eliminate ponding and direct runoff to perimeter ditches, sumps, and/or underdrains. The top surfaces of the tailings piles would be sloped toward the hillside and surface runoff would be collected in lined ditches and conveyed to lined contact water collection ponds. As described under “Tailings Conveyance” earlier in this section, emergency slurry storage ponds would be needed near the West Plant Site as an emergency disposal location, in the event that the filter plant temporarily shuts down.

Tailings Facility – Closure and Reclamation

The filtered tailings facilities would be constructed in horizontal lifts, thus the external slopes of the stack can be reclaimed starting early in the mine life, unlike slurry facilities that are unlikely to start embankment slope reclamation until after year 20. Because it is important to keep water away from the filtered facility, surface water diversion dams, tunnels, channels, and pipelines would be constructed where needed to direct the large upstream catchment runoff water away from the slopes and to limit erosion, and contact water would be directed to collection ponds for evaporation. After closure, upstream stormwater diversion features such as cutoff walls and channels would remain in place permanently to continue to direct surface water flows around and downstream of the tailings impoundments.

Active closure would be required for 5 years after the end of operations. During this time, reclamation of the exposed tailings would be in progress, and the need to retain stormwater in the collection ponds requires more capacity than the collection ponds can passively evaporate; active treatment may be required. Once stormwater can again be released downstream, after the tailings surface has been reclaimed with a stable closure cover, the collection ponds would be able to passively evaporate collected water. The sludge of concentrated metals and salts from evaporation would likely eventually require cleanup and handling as solid or hazardous waste.

The NPAG and PAG tailings piles would be treated as two separate facilities with separate covering, soil, and revegetation, but both stacks would use a store and release cover design to limit infiltration. At closure, the PAG tailings pile would be covered by an engineered low-permeability layer of compacted NPAG material that would be covered by a 1- to 2-foot layer of low-permeability, erosion-resistant soil (e.g., Gila conglomerate or equivalent soil, sand, and gravel mix) and revegetated. Other closure and reclamation measures, such as the removal of buildings, pipelines, electrical equipment and electrical lines, and the recontouring and revegetation of parking areas and other areas of ground disturbance, would be substantially identical to those described for Alternative 2.

Table 2.2.6-1 summarizes the components of the Silver King tailings storage facility.

Table 2.2.6-1. Summary of Alternative 4 – Silver King tailings storage facility

Tailings Storage Facility	Description
Location	Silver King Canyon (immediately north of and adjacent to the West Plant Site)
Land ownership	NFS
Distance from West Plant Site	1 mile
Tailings type and disposal	Filtered (dry stack) placed mechanically in two separate, but adjacent facilities At disposal—PAG tailings would be 86% solids content; NPAG tailings would be 89% solids content.
Tailings embankment	Perimeter of filtered pile would be compacted into a structural zone to provide physical support. The downstream slope would not exceed 3H:1V
Lining and other seepage controls	No lining of tailings, emergency temporary slurry ponds would be lined and retained by earthfill embankments. Seepage from the tailings would be recovered in five seepage collection ponds downstream of the facilities. Finger and blanket drains would underlie the tailings facilities.
Approximate size at fence line of tailings storage facility	5,661 acres
Approximate embankment height	The approximate maximum height of the filtered NPAG tailings facility is 1,040 feet and PAG tailings facility is 750 feet.
Tailings pipelines / conveyance	Thickened slurry would be pumped in two streams (PAG and NPAG) to the tailings storage facility and a recycled water pipeline would return water to processing loop at West Plant Site. There would be two filter plants (one for NPAG and one for PAG) at the Silver King tailings storage facility. After tailings are pressure filtered, they would then be placed within the facility by conveyor. 0.20 mile of corridor from West Plant Site to tailings storage facility.
Auxiliary facilities	Pressure filters, conveyors, mechanical spreaders, and mobile earthmoving equipment would be used for filtering and depositing the tailings. The filter plant and loadout facility would be relocated from the proposed location near Magma Junction to the West Plant Site. The facility would continue to pressure-filter the concentrate similar to the proposed process described in the GPO. Pipelines for copper concentrate and filtrate water would be located within the West Plant Site and not within the MARRCO corridor. Two 50-railcar trains would use the MARRCO corridor twice a day to transport copper concentrate to market. Permanent diversion channels upslope of the tailings pile would divert non-contact water around the tailings pile and discharge to either the West or East Diversion reservoirs. Multiple temporary slurry storage ponds would be required near the West Plant Site as emergency disposal locations in the event of planned or unplanned shutdowns. The ponds would be lined and retained by earthfill embankments.
Other design considerations	NFS Road 229 would need to be rerouted for private parcel access. 17.7 miles of NFS roads are expected to be decommissioned or lost. Approximately 5.5 miles of the Arizona National Scenic Trail would need to be rerouted. The 230-kV and 115-kV transmission lines would need to be crossed or rerouted between the East Plant Site and the West Plant Site.
Closure and reclamation	Reclamation and contouring of the filtered tailings would occur concurrently during mining operations. Reclamation would begin on outer slopes as early as practicable. Seepage and contact water collection ponds would remain in place until reclamation of tailings surfaces is complete, about 5 years after closure. Seepage ponds would remain in place to evaporate seepage or runoff unless water quality were sufficient to allow discharge.

2.2.7 Alternative 5 – Peg Leg

Alternative 5 – Peg Leg West Tailings Corridor Option would include approximately 17,285 acres of disturbance, of which 2,675 acres is NFS, 7,574 acres is BLM managed, 4,642 acres is ASLD managed, and 2,394 acres is private land.

Alternative 5 – Peg Leg East Tailings Corridor Option would include approximately 16,938 acres of disturbance, of which 2,752 acres is NFS, 7,105 acres is BLM managed, 4,659 acres is ASLD managed, and 2,422 acres is private land.

The Peg Leg alternative was developed to respond to the issues of public health and safety and groundwater quality. This alternative includes changes to the GPO for storing tailings, including the tailings facility location, tailings conveyance route to storage facility, and tailings storage embankment type. Public health and safety is addressed by locating the tailings facility in an area farther from residential populations and using a more resilient and robust embankment type than the upstream embankment proposed in the original GPO. Water quality is addressed by containing and controlling any seepage from the facility, and the greater distance to downstream perennial waters. Other plan components of the GPO remain the same as described in Alternative 2 – Near West Proposed Action.

The Peg Leg alternative tailings facility location is on a mixture of ASLD-administered and BLM-administered and private land south of the Gila River (figure 2.2.7-1). Selection of this alternative by the Forest Supervisor would not automatically approve this alternative, as BLM would require submittal of a mining plan of operations to approve the proposal. Since the other areas are not Federal land, obtaining access to use ASLD-administered trust land and private land is the responsibility of the applicant. The thickened slurry would be pumped from the West Plant Site in a split stream (approximately 84 percent NPAG and 16 percent PAG) via pipeline alternatives extending 28 miles on a western route and 23 miles on a proposed eastern route, and placed behind a centerline embankment retaining the larger NPAG tailings facility; the separate PAG cell would be situated behind a downstream embankment located adjacent to the NPAG impoundment. The PAG tailings would be kept saturated to prevent oxidation (the same as for the GPO).

This alternative tailings location was selected for its distance from residential areas and other infrastructure. The advantageous characteristics of this site include a greater distance from Superior, Queen Creek, and other communities, along with a gently sloping 4 percent topography on alluvial soils underlain by shallow bedrock on the eastern portion. This alternative also rose from a desire to consolidate mining activities on the landscape—this alternative is geographically close to the ASARCO Ray Mine complex and the planned Ripsey Wash tailings facility.

2.2.7.1 Alternative 5 Mine Plan Components

Water Use

This alternative uses about 540,000 acre-feet of groundwater pumped from the Desert Wellfield through the life of the mine (see appendix H). This is about 8 percent less water than under Alternative 2. This location has greater seepage losses to the aquifer. However, this increased water use is offset by the capture of more precipitation and runoff at this location and greater recovery of reclaimed water.

Tailings Facility – Tailings Type

Tailings types would be the same as described in Alternative 2 – Near West Proposed Action. The thickened tailings would consist of approximately 84 percent NPAG and 16 percent PAG.

The smaller PAG facility would be located on what is primarily granitic and granodiorite bedrock at the eastern portion of the Peg Leg facility footprint and would be constructed in a "four-square" pattern of separate cells as a way to reduce the pond size required for operations (i.e., the water cap needed to prevent airborne oxygen from interacting with the PAG tailings). The NPAG tailings would be located on what is primarily an alluvial material base immediately to the west and slightly downslope

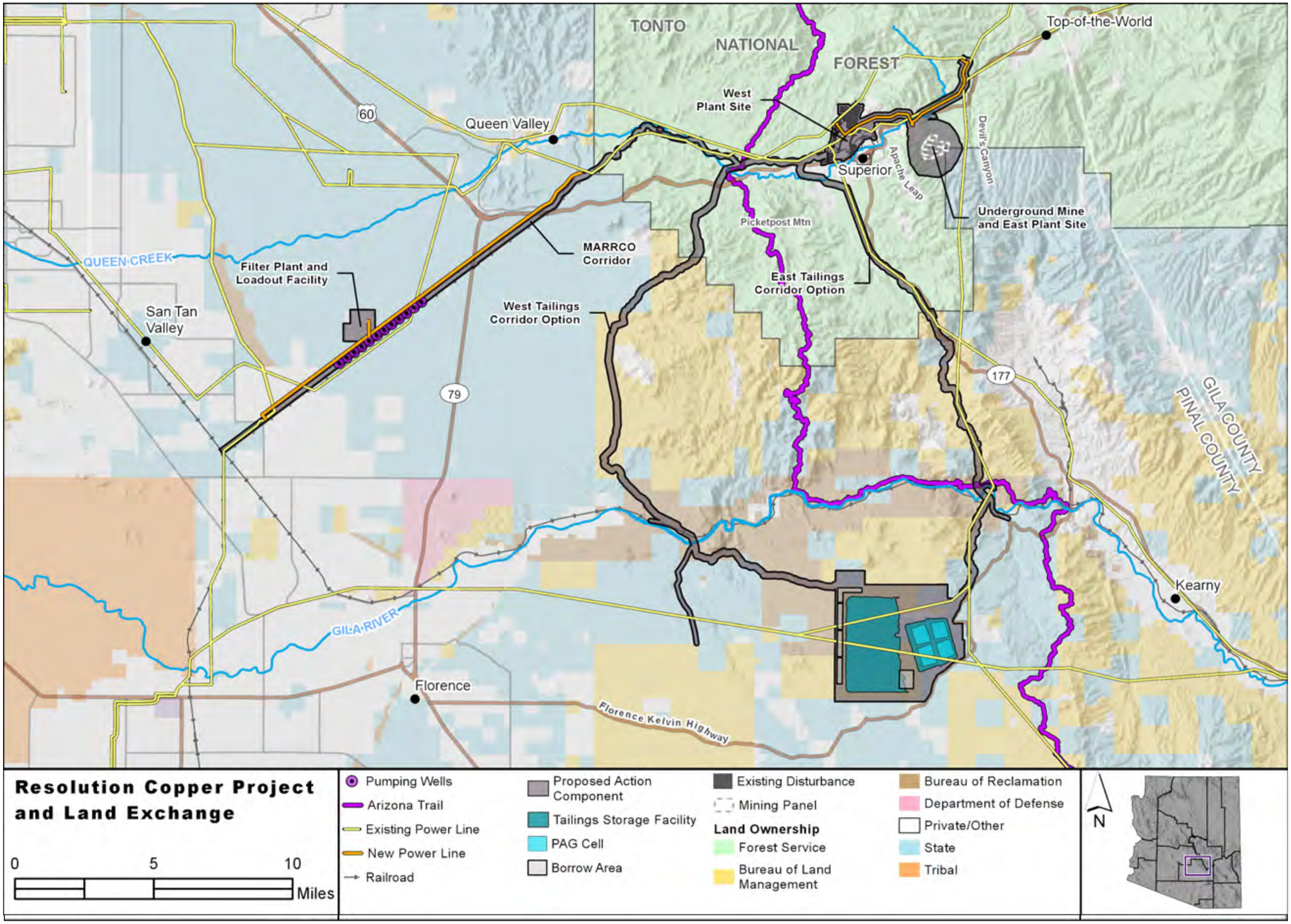


Figure 2.2.7-1. Alternative 5 – Peg Leg overview

from the PAG location. Figure 2.2.7-2 shows the tailings storage facility for this alternative.

Tailings Facility – Tailings Conveyance

The tailings would be pumped as a thickened slurry in two separate pipelines from the West Plant Site to the Peg Leg tailings storage facility approximately 25 miles to the south. Two pipeline corridor routes from the West Plant Site are presently being studied: a western alignment that would initially follow the MARRCO corridor south and then traverse primarily BLM-administered lands before crossing the Gila River and then turning eastward to the Peg Leg site, and an eastern alignment that would initially lie within the SR 177 easement and then shift more directly southward across BLM-administered and private lands before crossing the Gila River west of the Kelvin Bridge area prior to connecting to the Peg Leg facility (see figure 2.2.7-2).

Tailings Facility – Embankment Type

As stated, the Peg Leg tailings facility would comprise two physically separate types of storage facilities: PAG and NPAG. The two facilities would remain segregated throughout the entire life of the mine.

A "downstream" embankment design, which is material-intensive and requires a larger footprint to be designed as a water retaining embankment, is proposed for the PAG cell as it contains a water cover to limit oxidation. This embankment would be constructed using a mixture of earthfill excavated from within the tailings facility footprint and compacted cycloned sand. At the end of mine life, the PAG embankment would be approximately 200 feet in height. The entire PAG facility would include engineered low-permeability layers, or possibly a full synthetic liner.

The NPAG tailings would be retained behind a "centerline" design embankment[21] just to the west and slightly downstream of the PAG facility. The NPAG embankment would be constructed first using earthfill excavated from within the facility footprint, followed by compacted cycloned sand (underflow). The NPAG facility would be partially lined with an engineered low-permeability lining and other low-permeability layers under the recycled water pond area of the impoundment. At completion, the NPAG main embankment would be approximately 310 feet in height.

Tailings Facility – Liner

A full engineered low-permeability lining or other low-permeability layer would be installed at the PAG facility and partial engineered low-permeability lining positioned along the starter dam and under the recycled water pond within the NPAG impoundment (the full areal extent of the liner needed in the NPAG facility would be assessed and adjusted during operations). Other seepage containment techniques, such as use of low-permeability tailing fines (cyclone overflow), as well as grouting or sealing of fractures in base rock using asphalt or bentonite or other materials, may be used to augment the engineered low-permeability lining within both the PAG and NPAG cells.

Alternative 5 developed in part from the concept of a fully lined tailings facility. In practice, a full engineered low-permeability liner over such a large area would be both impractical and ineffective. However, because this alternative is located on alluvium, the potential water losses are expected to be substantial and a wide variety of seepage containment techniques would need to be employed to limit seepage to the extent possible and recover water for recycling back into the mine process (see section 3.7.2.4).

Embankment seepage would be captured in drains at the toe of the dams at each facility and collected in lined surface water and seepage

21. Care should be taken to not confuse "modified centerline" with "centerline" designs. The modified centerline embankment type still has some resemblance to an upstream embankment, in that the crest of the embankment does move upstream over time and the embankment lifts are still constructed partially over tailings. The true centerline design builds the crest straight upward and retains a solid core that is not underlain by tailings.

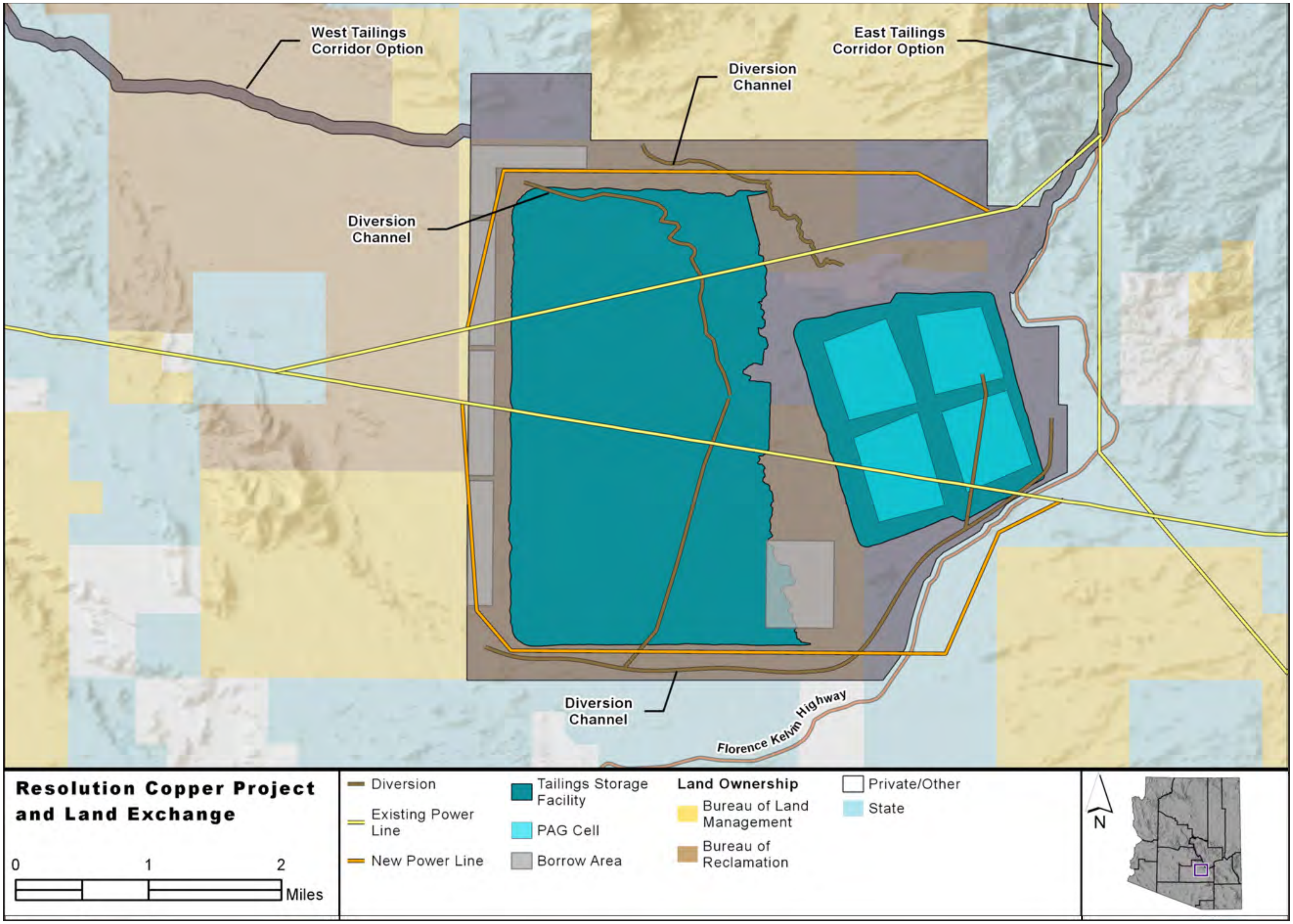


Figure 2.2.7-2. Alternative 5 – Peg Leg tailings storage facility

collection ponds. This collected water would then be pumped back to the recycled water ponds at each facility. A groundwater pumpback system would be operated downgradient of the tailings facility to recover seepage.

The uncontained seepage from the facility is expected to produce a groundwater mound. A well field would be installed downstream of the facility to further control seepage and groundwater would be pumped back to the recycled water pond.

Tailings Facility – Disposal Method

Tailings would be deposited by pipeline to their respective cells around each embankment. In this alternative, the PAG tailings would be deposited subaqueously. NPAG slurry would initially be deposited using traditional methods but would later transition to “thin-lift” (i.e., thin layer) deposition techniques to further increase evaporation and reduce seepage.

Tailings Facility – Auxiliary Facilities

Stormwater diversion channels and retention structures would be needed to manage stormwater runoff from the NPAG and PAG cells and to manage upstream (upslope) storm flows. Cutoff walls and diversion berms and channels would be constructed on the northern, eastern, and southern boundaries of the tailings facility to divert stormwater flows around the tailings impoundments.

Additional facilities that would support operations at the Peg Leg site would include electrical power lines and a substation; a cyclone separation plant; water pumping facilities for the PAG cells; collection ponds; a vehicle maintenance and fuel shop; an administration/maintenance building; an equipment storage building; and vehicle parking areas.

Existing powerlines would need to be rerouted around the tailings facility, including a 115-kV SRP powerline and a 12.5-kV San Carlos Irrigation Project powerline as shown in figure 2.2.7-2.

Tailings Facility – Closure and Reclamation

A difference in the management of this alternative with tailings stored in perpetuity on BLM-managed lands, would require the GPO to remain active along with any reclamation bonds for many decades. After final tailings deposition and formal closure of the Peg Leg tailings storage facility, the surfaces of both the NPAG and PAG facilities would be shaped as necessary to prevent standing water. Surface water diversion features, including channels, would be constructed to limit erosion and direct precipitation that falls within the facilities to lined collection ponds to evaporate. Upstream diversion features would continue to direct stormwater flows around and downstream of the two impoundments; these structures would permanently remain in place after all other closure and disassembly/removal work had concluded.

The NPAG facility would be covered with 1 to 2 feet of low-permeability, erosion-resistant soil (e.g., Gila conglomerate, or a sand, soil, and gravel mix) and revegetated. The PAG facility is separated into four separate cells to reduce the footprint of saturated tailings, thus reducing seepage and to promote early closure and reclamation. Each PAG cell would operate for approximately 10 years and would then be closed. The PAG facility would first be covered with a minimum of 10 feet of NPAG material, then topped with a similar 1- to 2-foot thickness of erosion-resistant soil and revegetated.

The seepage collection ponds would remain in place and passively evaporate seepage, and seepage extraction wells downstream would remain in place to control seepage as long as necessary. These seepage features are estimated to be in place between 100 to 150 years after closure. Once the collection ponds can be closed, the closure plan calls for encapsulating the accumulated sludge in geomembrane and backfilling with soil.

Other closure and reclamation measures, such as the removal of buildings, pipelines, electrical equipment and electrical lines, and the recontouring and revegetation of parking areas and other areas of ground disturbance, would be substantially identical to those described for Alternative 2.

Table 2.2.7-1 summarizes the components of the Peg Leg tailings storage facility.

Table 2.2.7-1. Summary of Alternative 5 – Peg Leg tailings storage facility

Tailings Storage Facility	Description
Location	South of the Gila River
Land ownership	ASLD, BLM, private
Distance from West Plant Site	15
Tailings type and disposal	Thickened slurry tailings placed subaqueously for PAG tailings from barge in one of four cells, NPAG placed hydraulically from perimeter in a thin-lift deposition once feasible At disposal—PAG tailings would be 50% solids content; thickened cyclone overflow (NPAG) would be 60% solids content; and thickened NPAG stream sent directly from the mill would be 60% solids content.
Tailings embankment	Cyclone sand centerline-type embankment at NPAG facility with a 3H:1V slope; earthfill and cyclone sand downstream-type embankment at PAG facility
Lining and other seepage controls	Foundation treatments and/or low-permeability liners and layers under the entire PAG cell, under the NPAG starter cell, and where needed under the rest of the NPAG facility, depending on foundation conditions Seepage from the tailings would be recovered in six seepage collection ponds downstream of the embankments. The seepage and stormwater collected at the collection ponds would be managed during operations for use in the process water system. Finger and blanket drains would underlie the embankment and part of the NPAG tailings. Seepage collection pumpback wells would be placed downstream of tailings storage facility.
Approximate size at fence line of tailings storage facility	10,782 acres
Approximate embankment height	310 feet NPAG; 200 feet PAG
Pipelines / conveyance	Thickened slurry pumped in two streams (PAG and NPAG) to the tailings storage facility and recycled water pipeline to return water to processing loop at West Plant Site West Option: 28 miles of corridor from West Plant Site to tailings storage facility East Option: 23 miles of corridor from West Plant Site to tailings storage facility
Auxiliary facilities	Booster pumps may be located at West Plant Site to improve pumping across topography. Diversions will divert water around the facility and back into downstream channels.
Other design considerations	Two transmission line corridors would need to be crossed and both transmission line corridors rerouted around the Peg Leg site. The Arizona National Scenic Trail would need to be crossed by the tailings pipeline corridors. No NFS roads are expected to be decommissioned or lost due to the tailings storage facility at Peg Leg, although BLM estimates 29 miles of inventoried routes would be directly affected.
Closure and reclamation	Reclamation of the tailings embankment face would not occur until construction of the tailings embankment face is complete, which would be at the end of the mining operations (approximately mine year 46). Seepage ponds would remain in use roughly 30 years after closure; groundwater pumpback system would remain in use roughly 20 years after closure.

2.2.8 Alternative 6 – Skunk Camp

Alternative 6 – Skunk Camp North Tailings Corridor Option would include approximately 15,872 acres of disturbance of which 3,265 acres is NFS, 7,923 acres is ASLD managed, and 4,684 acres is private land.

Alternative 6 – Skunk Camp South Tailings Corridor Option would include approximately 16,324 acres of disturbance of which 3,461 acres is NFS, 8,161 acres is ASLD managed, and 4,702 acres is private land.

The Skunk Camp alternative was developed to respond to the issues of public health and safety, groundwater quality, impacts on scenic resources and recreational opportunities and to limit the impacts on NFS surface resources. This alternative includes changes to the GPO for storing tailings, including the tailings facility location, tailings conveyance, and tailings storage embankment type. Public health and safety is addressed by locating the tailings facility in an area farther from specifically established towns and population centers. Groundwater quality is addressed by containing and controlling seepage from the facility. Additionally, the proposed Skunk Camp location is much less likely to adversely impact recreational users of public lands than the GPO location, and would be largely out of public view. Like Alternative 5, this alternative also rose in part from the desire to consolidate mining disturbance on the landscape; the Skunk Camp location is just east of the ASARCO Ray Mine. Other plan components of the GPO remain the same as described in Alternative 2 – Near West Proposed Action.

The Skunk Camp alternative tailings facility location is on a mixture of ASLD-administered and private land that would occupy the upper portion of Dripping Spring Valley, the northeastern slopes and foothills of the Dripping Spring Mountains, and the southwestern foothills of the Pinal Mountains, including a 4-mile reach of Dripping Spring Wash, a 3.5-mile reach of Stone Cabin Wash, and a 4.8-mile reach of Skunk Camp Wash. The proposed site lies approximately 2 miles due east of the existing ASARCO Ray Mine and approximately 13 miles north of the point where Dripping Spring Wash drains into the Gila River (figure 2.2.8-1). Selection of this alternative by the Forest Supervisor would not automatically approve this alternative, since the other areas are not Federal land, obtaining access to use ASLD-administered trust land and private land is the responsibility of the applicant.

The Forest Service has identified Alternative 6 – Skunk Camp as the Lead Agency's preferred alternative and seeks public feedback during the 90-day comment period for the DEIS regarding this choice.

2.2.8.1 Alternative 6 Mine Plan Components

Water Use

This alternative would need about 540,000 acre-feet of groundwater pumped from the Desert Wellfield through the life of the mine (see appendix H), or about 8 percent less water than under Alternative 2.

Tailings Facility – Tailings Type

Tailings types would be the same as described in Alternative 2 – Near West Proposed Action. The PAG tailings would be thickened at the West Plant Site. The thickened tailings would consist of approximately 84 percent NPAG and 16 percent PAG. Figure 2.2.8-2 shows the tailings storage facility for this alternative.

Tailings Facility – Tailings Conveyance

The two separate tailings streams (PAG and NPAG) would be piped as a thickened slurry from the West Plant Site to the Skunk Camp tailings storage facility, located approximately 14 miles (straight line) southeast of the West Plant Site. Like Alternative 5, two different route options from the West Plant Site are presently being studied. See figure 2.2.8-1 for both pipeline routes under consideration.

Tailings Facility – Embankment Type

As stated, the Skunk Camp tailings facility would comprise two physically separate starter facilities: PAG and NPAG (see figure 2.2.8-2).

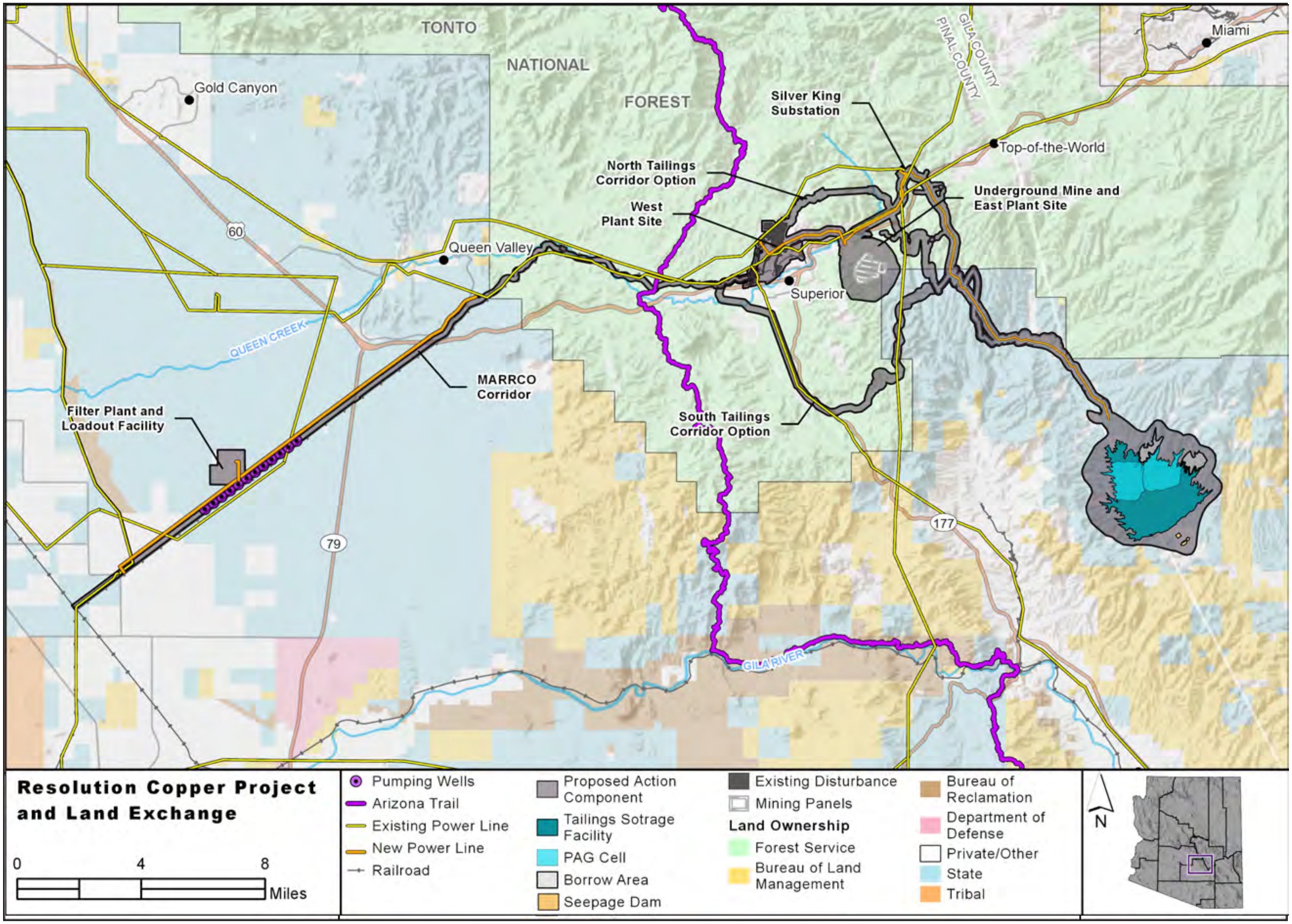


Figure 2.2.8-1. Alternative 6 – Skunk Camp overview

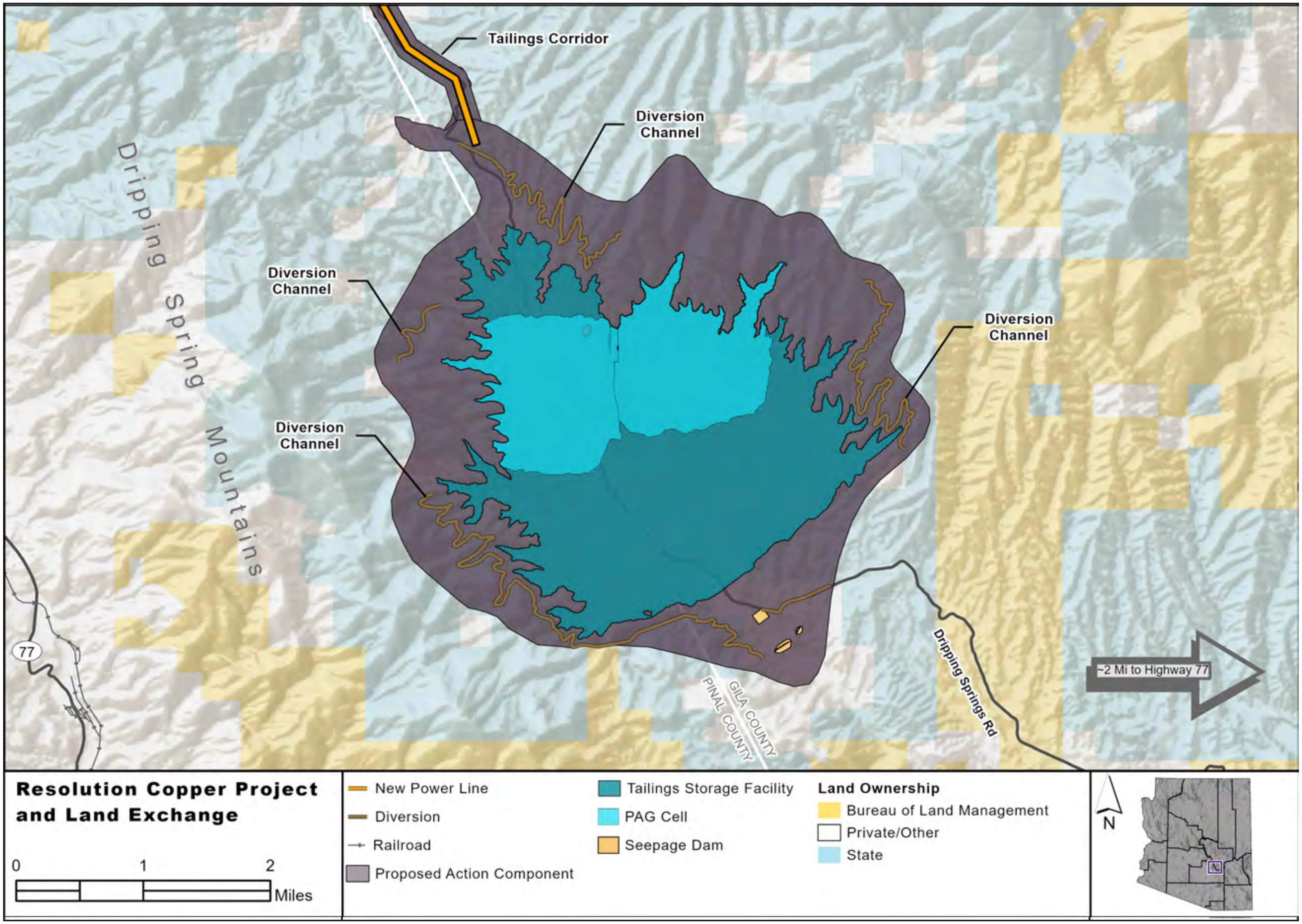


Figure 2.2.8-2. Alternative 6 – Skunk Camp tailings storage facility

Once delivered as a slurry to the Skunk Camp site, NPAG tailings would be cycloned to separate the coarser particles for use as embankment fill for part of the year, with the cyclone overflow (i.e., finer particles) being thickened at the tailings storage facility site before discharge into the impoundment. PAG tailings would be deposited into two separate cells, operated sequentially behind a separate cycloned sand embankment, to the north (upstream) end of the facility until they are encapsulated by the NPAG tailings.

The PAG and NPAG cells would be impounded by separate cross-valley starter embankments initially constructed of borrow material from within the ultimate tailings facility footprint. The impoundments would then periodically be raised in elevation during operations with compacted cycloned sand fill. The NPAG cell would use the centerline embankment construction approach, while the PAG cells would be constructed as downstream dams. The NPAG embankment would contain an underdrain system comprising sand and gravel blanket and finger drains (primarily along main drainages, with some extended beneath the NPAG beach) to maintain a low saturated surface in the tailings embankment and to intercept and direct seepage from the impoundment to the downstream seepage collection system ponds.

At full buildout, the embankment containing the NPAG tailings would be approximately 490 feet in height. As stated, the PAG cell embankment would be behind (upstream) and ultimately contained within the larger NPAG deposit.

Tailings Facility – Liner

To limit seepage under or around the Skunk Camp tailings storage facility, the PAG cell would incorporate an engineered low-permeability layer on the foundation and on the upstream face of the containment embankment. Engineered low-permeability layer containment could comprise one or more of the following: engineered low-permeability liner, compacted fine tailings, asphalt, slurry bentonite, cemented paste tailings, etc. To collect seepage downstream of the tailings storage facility, a foundation cut-off wall at the seepage collection pond would be constructed.

A single downvalley seepage collection pond would be the primary means for seepage and embankment construction and surface water collection during operations, with the collected water then pumped to a recycled water pond located within the operating PAG cell for use as process water at the cyclone house and/or at the West Plant Site, or for dust management at the tailings storage facility.

Tailings Facility – Disposal Method

Tailings would be deposited by pipeline to their respective cells around each embankment. In this alternative, the PAG tailings would be deposited subaqueously. NPAG slurry would initially be deposited using traditional methods.

Tailings Facility – Auxiliary Facilities

Five diversion dams, five diversion channels, and two non-contact water surface water pipelines would be constructed along the east and west sides of the tailings storage facility to intercept and route the upstream catchments around the facility. Collection ditches would be constructed along the embankment toe and at underdrain discharges to convey contact water to the seepage collection pond. Additional facilities at the Skunk Camp site would include the cyclone processing system (building to house the hydrocyclone(s), slurry dilution tanks, storage tanks, and associated equipment); an electrical substation and electrical distribution lines; a vehicle maintenance and fuel shop; equipment storage warehouse; administration and locker room facilities; and parking areas.

This is the only alternative that would require new transmission lines rather than tying into local lines nearby the facility. A new power line would be constructed from the existing Silver King substation north of U.S. 60 and Oak Flat that would follow a southeast alignment for 11.7 miles to the Skunk Camp location. Preliminary assessment of line voltage options show that either a 69-kV or 115-kV voltage level would be adequate to supply power to Skunk Camp. Further assessment by the electrical utility operating Silver King substation would be needed to

determine the adequate voltage and construction engineering, including access roads to service Skunk Camp.

Tailings Facility – Closure and Reclamation

Toward the end of operations, the tailings would be deposited or regraded to slope toward the north. At the end of operations, the remaining area of PAG tailings would be covered with a minimum 10-foot layer of NPAG tailings. The surfaces of both the NPAG and PAG facilities would be shaped to prevent standing water and divert runoff into channels leading to the downstream collection pond, and both NPAG and PAG areas would be covered by a 1- to 2-foot layer of low-permeability, erosion-resistant soil (e.g., Gila conglomerate or equivalent soil, sand, and gravel mix) and revegetated. The timing of reclamation is dependent on the surface being dry enough to allow equipment access for reclamation. A closure channel would be cut into the ridge between the tailings storage facility and the Mineral Creek drainage to convey the closed tailings storage facility runoff north.

Estimated seepage rates suggest active closure would be required up to 20 years after the end of operations. Up to 5 years after closure, the recycled water pond is still present and therefore all engineered seepage controls could remain operational. After 5 years, the recycled water pond is no longer present and seepage collection ponds would be expanded to maximize evaporation with active water management until the ponds could passively evaporate all incoming seepage (estimated at 20 years). The sludge containing concentrated metals and salts from evaporation would likely require cleanup and handling as a solid or hazardous waste.

Other closure and reclamation measures, such as the removal of buildings, pipelines, electrical equipment and electrical lines, and the recontouring and revegetation of parking areas and other areas of ground disturbance, would be substantially identical to those described for Alternative 2. Upstream (upslope) surface water diversion walls, channels, and other stormwater control elements would remain permanently in place to continue to direct surface flows around and downstream of the tailings impoundments. Final reclamation plans would include the designs and long-term requirements for maintenance of these permanent facilities.

Table 2.2.8-1 summarizes the components of the Skunk Camp tailings storage facility.

Table 2.2.8-1. Summary of Alternative 6 – Skunk Camp tailings storage facility

Tailings Storage Facility	Description
Location	In Dripping Spring Wash approximately 13 miles north of confluence with the Gila River
Land ownership	ASLD, private
Distance from West Plant Site	15 miles
Tailings type and disposal	Thickened slurry tailings placed subaqueously for PAG tailings from barge in one of two cells, NPAG placed hydraulically from perimeter At disposal—PAG tailings would be 50% solids content; thickened cyclone overflow (NPAG) would be 60% solids content; and thickened NPAG stream sent directly from the mill would be 60% solids content.
Tailings embankment	Earthen starter dams raised with compacted cyclone sand. The NPAG facility would be a centerline construction approach with a 3H:1V slope and the PAG cells would be a downstream construction approach with a 2.5H:1V slope.
Lining and other seepage controls	Engineered, low-permeability layers would be installed on PAG cell foundation and the upstream slope of the embankment.
Approximate size at fence line of tailings storage facility	10,072 acres
Approximate embankment height	490 feet
Pipelines / conveyance	Thickened slurry pumped in two streams (PAG and NPAG) to the tailings storage facility and recycled water pipeline to return water to processing loop at West Plant Site North Option: 19.78 miles of corridor from West Plant Site to tailings storage facility South Option: 25.18 miles of corridor from West Plant Site to tailings storage facility
Auxiliary facilities	Surface water diversions would be large due to the steep surrounding terrain and need to surround the tailings facility on northern, eastern, and western sides with extensive stormwater diversion structures.
Other design considerations	No NFS roads are expected to be decommissioned or lost due to the tailings storage facility at Skunk Camp, although BLM has identified loss of access to mining activities and grazing facilities.
Closure and reclamation	Reclamation of the NPAG tailings embankment face would begin as soon as the slope reaches its final extent starting at approximately mine year 10–15. The top of the tailings storage facility would not be reclaimed until after mining is complete. Closure of the tailings recycled water pond is estimated to take up to 5 years after closure. Until that time, excess seepage in seepage ponds would be pumped back to the recycled water pond, and reclamation would take place on the embankment and tailings beaches. After the recycled water pond is closed, seepage ponds would be used to evaporate seepage, and the remaining reclamation of the tailings surface would occur.

2.2.9 Alternative GPO Components Common to All Action Alternatives

Minor modifications to two facilities proposed in the GPO have been considered in order to address specific resource impacts. These "alternative components," described in the following subsections, may be applied to the proposed action or any of the action alternatives.

2.2.9.1 Relocation of Process Water Pond within West Plant Site

This alternative component would move the process water pond, as proposed in the GPO, off approximately 11.4 acres of NFS land immediately north of and adjacent to the West Plant Site and relocate the pond and associated facilities (e.g., fencing, stormwater control systems) fully within Resolution Copper private property boundaries on the western portion of the West Plant Site (figure 2.2.9-1).

As noted earlier, this potential amendment to the GPO was voluntarily brought to the attention of Tonto National Forest staff by representatives of Resolution Copper, who suggested this particular modification as a relatively low-cost change the company could make to reduce overall project impacts on NFS surface resources. It is anticipated that this alternative component to the GPO would be implemented under any project alternative and regardless of the site ultimately selected for location of the tailings storage facility and associated linear project features such as slurry pipelines and power lines.

2.2.9.2 Redesign and/or Improvement of Vehicle Access to and from the West Plant Site

Resolution Copper is also proposing an alternative routing of Silver King Mine Road (NFS Road 229), which would be used to transport mine personnel, equipment, supplies, and molybdenum and other mine products, to and/or from the West Plant Site (see figure 2.2.2-8). This rerouting is anticipated to reduce typical use of NFS Road 229 by mine personnel from 2.3 miles, as described in the GPO, to just 0.4 mile. It is anticipated that this alternative component to the GPO would be implemented under any project alternative and regardless of the site ultimately selected for location of the tailings storage facility and associated linear project features such as slurry pipelines and power lines.

2.3 Mitigation Common to All Action Alternatives

Mitigation measures, as defined by the CEQ regulations (40 CFR 1508.20), include the following:

- Avoiding the impact altogether by not taking a certain action or parts of an action;
- Minimizing impacts by limiting the degree or magnitude of the action and its implementation;
- Rectifying the impact by repairing, rehabilitating, or restoring the affected environment;
- Reducing or eliminating an impact over time, through preservation and maintenance operations during the life of the action; and
- Compensating for an impact by replacing or providing substitute resources or environments.

The Forest Service has developed mitigation measures and monitoring actions to be included as project design features in the proposed action and action alternatives. The effectiveness of the mitigation measures and monitoring actions has been evaluated as part of the projected impacts analyses for the proposed action and action alternatives. Refer to the impacts analyses in chapter 3 for further detail.

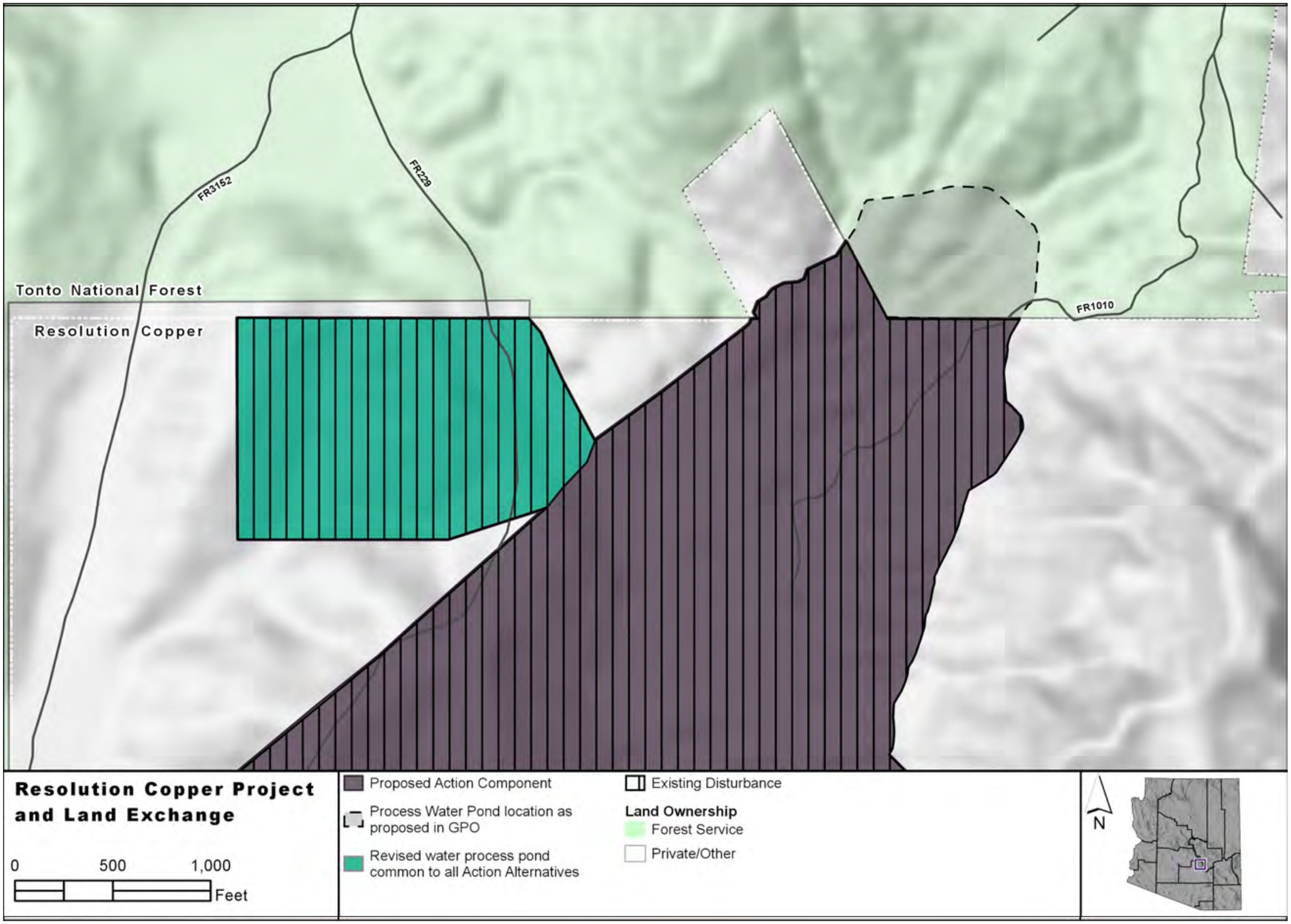


Figure 2.2.9-1. Relocation of process water pond within West Plant Site

2.3.1 Mitigation and Monitoring

The Forest Service has developed mitigation and monitoring actions that are evaluated in chapter 3 to be included in the proposed action and action alternatives. The framework for the project mitigation and monitoring plan is contained in appendix J of this DEIS. It is important to note that the full suite of mitigation measures and monitoring actions would not be known until many or most of the required permits have been issued, which often contain required measures intended to avoid or reduce environmental effects. It is fully expected that a more detailed and complete monitoring plan would be contained in the FEIS and ROD and ultimately included in the final GPO.

2.3.1.1 Authority

The CEQ (2011) states that agencies should not commit to mitigation measures absent the authority or expectation of resources to ensure that the mitigation is performed. The framework mitigation and monitoring plan is designed to clearly disclose which mitigation and monitoring items are within the authority of the Forest Service, or other regulatory and permitting agencies, such as the USACE, Arizona Department of Environmental Quality (ADEQ), and Arizona Department of Water Resources (ADWR).

Forest Service

The role of the Forest Service under its primary authorities in the Organic Administration Act, Locatable Regulations (36 CFR 228 Subpart A), and Multiple-Use Mining Act is to ensure that mining activities minimize adverse environmental effects on NFS surface resources.

Forest Service mitigation measures and monitoring are items that would help to minimize impacts on Forest Service surface resources; or are required by the project's U.S. Department of the Interior Fish and Wildlife Service (FWS) biological opinion, and the project's Programmatic Agreement (PA) with the Arizona State Historic Preservation Office (SHPO) and other signatories for compliance with the National Historic Preservation Act. The Forest Service is responsible for determining whether the implementation of mitigation and the results of monitoring comply with the decision that would be documented in the ROD and in compliance with the final GPO.

The Forest Service has no authority, obligation, or expertise to determine or enforce compliance with other agencies' laws or regulations. The Forest Service seeks to coordinate with other agencies to approve a legally compliant final GPO; however, it is the operator's responsibility to ensure that its actions comply with applicable laws.

Other Regulatory and Permitting Agencies

Mitigation and monitoring items under this heading are within the authority of other regulatory permitting agencies, including the ADEQ, ADWR, ASLD, BLM, Pinal County Air Quality District, and USACE. Mitigation and monitoring measures under this authority include permit requirements and stipulations from legally binding permits and authorizations, such as the air quality permit, Aquifer Protection Permit, and groundwater withdrawal permit (see appendix H for a complete listing of permit requirements and stipulations). These other regulatory and permitting agencies would share monitoring results and any instances of non-compliance with the Forest Service. The Forest Service would use the information provided by the regulatory and permitting agencies to determine compliance with the decision that would be documented in the ROD and compliance with the final GPO.

Resolution Copper

Resolution Copper has agreed to implement additional mitigation and monitoring measures in the mitigation and monitoring plan that are outside the scope of the authorities listed here. As these were considered as required in the resource analyses, the final ROD would require these mitigations be enforced. These include contractual, financial, and other agreements over which the Forest Service and other regulatory agencies have no jurisdiction. The Forest Service and regulatory agencies have no authority, obligation, or expertise to determine or enforce

compliance of these measures. Since the Forest Service and regulatory permitting agencies cannot require implementation of the mitigation and monitoring measures in this authority, their implementation is not guaranteed until required by a signed final ROD and revised GPO with the mitigations included. The effectiveness of these mitigation measures is included in chapter 3 impact analyses.

2.3.1.2 Applicant-Committed Environmental Design Measures

Applicant-committed environmental design measures are features incorporated into the design of the project by Resolution Copper to reduce potential impacts on resources. These measures would be non-discretionary as they are included in the project design, and their effects are accounted for in the analysis of environmental consequences disclosed in each resource section of chapter 3.

2.3.1.3 Monitoring and Evaluation

Monitoring is fundamental for ensuring the implementation and effectiveness of mitigation commitments, meeting legal and permitting requirements, and identifying trends and possible means for improvement (Council on Environmental Quality 2011). CEQ regulations explicitly require that “a monitoring and enforcement program shall be adopted . . . where applicable for any mitigation” (40 CFR 1505.2(c)). In addition, any adaptive management approaches “must also describe the monitoring that would take place to inform the responsible official whether the action is having its intended effect” (36 CFR 220.5(e)). Detailed monitoring plans would be incorporated by reference into the agency’s decision document to ensure that they are legally binding. The following monitoring plans would identify the monitoring area, the monitoring systems, and future actions if thresholds are triggered:

- Subsidence management plan (appendix to GPO)
- Groundwater mitigation and monitoring plan
- Road use plan (appendix to GPO)
- Environmental emergency and response and contingency plan (appendix to GPO)
- Fire prevention and response plan (appendix to GPO)
- Preliminary spill prevention control and countermeasures plan (SPCC) (appendix to GPO)
- Explosives management plan (appendix to GPO)
- Acid rock drainage management plan (appendix to GPO)
- Hydrocarbon management plan (appendix to GPO)
- Environmental materials management plan (appendix to GPO)
- Preliminary stormwater pollution prevention plan (SWPPP) (appendix to GPO)
- Wildlife management plan (appendix to GPO)
- Noxious weed and invasive species plan (Resolution Copper 2019)
- Historic properties treatment plan for Oak Flat land exchange parcel (Deaver and O’Mack 2019)
- Historic properties treatment plan for GPO (in process)
- Tailings pipeline management plan (AMEC Foster Wheeler Americas Limited 2019)
- Concentrate pipeline management plan (M3 Engineering and Technology Corporation 2019b)

Monitoring and evaluation activities would be prescribed, conducted, and/or reviewed by Resolution Copper, the Forest Service, and other agencies with regulatory or permitting authority. Resolution Copper would fund monitoring as set forth in the ROD, approved final GPO, and the final mitigation and monitoring plan. Other monitoring activities

may be associated with the regulatory authority of other Federal and State agencies and would be funded by permit fees or the agencies themselves as part of their normal activities.

Evaluation and Reporting

Resolution Copper would submit an annual report to the Forest Service that contains a description of all activities conducted on NFS lands during the previous year and a summary of the amount of acreage disturbed, status of reclamation, spills or releases of chemicals or fuel, and results of all monitoring plans in a format approved by the Forest Service, including a complete data summary and any data trends, status of mining plan (tons of ore and waste mined and any changes to methods or equipment), and plans for the coming year. In addition to annual reporting, individual monitoring measures would also specify reporting requirements, which could include short-term emergency notification (for example, reporting spills within 72 hours) and interim reports (such as quarterly reports). The Forest Service would review reporting to ensure that mitigation commitments were implemented on NFS lands and the effectiveness of the mitigation. Significant changes would be required to be incorporated into the approved final GPO and reflected in financial assurance. Past, ongoing, or projected impacts on the environment may also require amendment of the approved final GPO, ROD, and/or financial assurance held for the project.

2.3.1.4 Financial Assurances

As part of the approval of a final GPO, the Forest Service would require Resolution Copper to post financial assurance, or reclamation bond, that would provide adequate funding to allow the Forest Service to complete reclamation and post-closure operation, maintenance activities, and necessary monitoring on NFS land for as long as required to return the site to a stable and acceptable condition. The amount of financial assurance would be determined by the Forest Service and would "address all Forest Service costs that would be incurred in taking over operations because of operator default" (U.S. Forest Service 2004). The financial assurance would be required in a readily available bond instrument payable to the Forest Service. In order to ensure that the bond can be adjusted as needed to reflect actual costs and inflation, there would be provisions allowing for periodic adjustment on bonds in the final GPO prior to approval.

The reclamation bond amount is an estimate of both direct and indirect costs to reclaim the operation, based on contractors performing the work. This estimate is also to consider the time of operation in which reclamation costs would peak. This cost peak can be determined by looking subjectively at the mine schedule and timing of greatest areas and volumes of disturbance and materials or quantitatively calculating reclamation costs on an annual basis. As reclamation plans evolve from conceptual designs during permitting to as-built designs during construction, the bond estimates and requirements would be adjusted. Further, "Reclamation standards and bond estimates (with accompanying details) become legally binding when the operator changes the proposed Plan of Operation to include them, posts the required bond, and is notified by the authorized officer that the Plan of Operation is approved" (U.S. Forest Service 2004).

Other agencies also require separate financial assurance. The USACE requires financial assurance under Section 404 of the CWA where applicable. The ADEQ, ASLD, and Arizona State Mine Inspector also require bonds as part of their permitting authority. The BLM would require bonds if the project occurred on lands under their permitting authority. The APP requires bonding for closure and groundwater protection. Since the components of the final decision are unknown at this time, it is premature for the Forest Service to calculate bond.

Further discussion of financial assurance is included in section 1.5.5, and in certain sections of chapter 3, including section 3.3 (Soils and Vegetation), 3.7.2 (Groundwater and Surface Water Quality), and 3.10.1 (Tailings and Pipeline Safety).

2.4 Effects of the Land Exchange

As described in section 2.2.3.1, a completed land exchange is considered for all resource analyses in chapter 3.

Physically, the panel caving proposed to take place under Oak Flat is independent of the land exchange. The deposit would be mined with fundamentally the same techniques and require fundamentally the same infrastructure, and result in the same surface subsidence, regardless of whether the surface is under Forest Service jurisdiction or is private. The two primary differences are (1) the regulatory framework under which mining would occur "with" or "without" Federal oversight, and (2) without the land exchange, minerals underneath the withdrawal boundary could not be extracted. If a land exchange does not occur, Resolution Copper would mine and reclaim the mined land under Federal, State, and local permits and an approved GPO under 36 CFR 228 Subpart A. If the land exchange does occur and the Oak Flat area becomes private lands, Resolution Copper would be required to conduct its activities in accordance with all applicable Federal, State, and local permits but may not be subject to the requirement of obtaining an approved GPO under 36 CFR 228 Subpart A.

Mine operations are governed by several Federal, State, and local regulatory frameworks. Each of the regulatory frameworks is founded in statute and implemented through regulations and policies of the responsible agency. Agency regulations or rules provide guidance to the agency so it can implement the laws and provide guidance to mine operators so they can follow the laws. Each agency requires certain types of information (filing requirements) before it can process and issue permits under its regulations. Many of the filing requirements for permits from the various agencies are duplicative, even though each agency has its own regulatory authority and responsibilities. Performance standards specify the norm governing how operations would occur and describe the level of compliance expected by the agency.

Performance standards required by the Forest Service for mining on Federal land are contained in 36 CFR 228.8: "All operations shall be conducted so as, where feasible, to minimize adverse environmental impacts on National Forest surface resources." These include specific requirements for air quality, water quality, solid waste, scenery values, fishery and wildlife habitat, roads, and reclamation.

State agencies have similar performance standards. For example, the goal of the State's Aquifer Protection Permit program is to ensure no degradation of the state's groundwater. ADEQ ensures this goal by implementing the performance standards outlined by the best available demonstrated control technology (Arizona Department of Environmental Quality 2004). Also, the goal of the state mined land reclamation rules is to ensure safe and environmentally sound reclamation of mined lands. The Office of the Arizona State Mine Inspector ensures this goal by requiring operators to meet operational and post-mine performance standards specified in the regulations at Arizona Revised Statutes (ARS) R11-2-601 *et seq*.

To ensure consistency, Federal, State, and local agencies in Arizona typically require that operators follow all other Federal, State, and local permit requirements and standards. The Forest Service specifies this explicitly for air quality (36 CFR 228.8(a)), water quality (36 CFR 228.8(b)), and solid waste (36 CFR 228.8(c)). Regulation also allows for certification or approval issued by State agencies or other Federal agencies to be accepted by the Forest Service as compliance with similar or parallel Forest Service regulations (36 CFR 228.8(h)).

While there is substantial overlap in many resources, there are also some resources that may lack any form of regulatory protection except under Federal jurisdiction. For instance, Forest Service regulations address scenic values (36 CFR 228.8(d)) and fisheries and wildlife habitat (36 CFR 228.8(e)), both of which are afforded little specific protection solely under other applicable Federal or State laws, the notable exception being species that are federally listed under the ESA.

A discussion of the differences in the regulatory framework if the land exchange occurs (mining occurs on private land) vs. if the land exchange does not occur (mining occurs under Forest Service jurisdiction) is included in appendix I.

2.5 Comparison of Alternatives

This section provides a summary of the effects of implementing each alternative. The information on the following pages is focused on

activities and effects where different levels of effects or outputs can be distinguished quantitatively or qualitatively between alternatives. See also Appendix E, Alternatives Impact Summary.

GEOLOGY, MINERALS, AND SUBSIDENCE — DEIS SECTION 3.2

Key factors to analyze the issue of geology, minerals, and subsidence	What are the results of impact analysis for the proposed action (Alternative 2)?	Are the analyzed impacts of these issues substantially different under Alternatives 3, 4, 5, or 6?
• Assessment of the extent, amount, and timing of land subsidence, with estimates of uncertainty • Assessment of potential public health risk from geological hazards, including seismic activity • Assessment of the potential to impact caves or karst resources, and paleontological resources • Assessment of impact on unpatented mining claims	Modeling indicates the subsidence area would first become evident at the surface at Oak Flat in mine year 6 or 7. At full mine development in year 40 or 41, the subsidence area is expected to be approximately 800–1,115 feet deep and approximately 1.8 miles in diameter. No damage is anticipated at Apache Leap, Devil's Canyon, or U.S. 60. Resolution Copper has stated they would cease mining additional subsurface panels if through ongoing monitoring it appears any of these areas would be impacted (see "Subsidence Impacts" in section 3.2.4.2). Potential risks to public safety from mine-induced seismic or other geological activity are low. Induced mine seismicity is possible, but unlikely to be of sufficient magnitude to cause structural damage (see "Geological Hazards" in section 3.2.4.2). With the exception of a small outcropping of Martin limestone that would be destroyed in the tailings facility footprint, no surface areas or geological units with known potential for caves, karsts, or paleontological resources are located within the predicted areas of disturbance (see "Paleontological Resources" and "Caves and Karst" in section 3.2.4.2). Access may be inhibited to non–Resolution Copper unpatented load or placer mining claims located under the tailings storage facility and pipeline (see "Unpatented Mining Claims" in section 3.2.4.2).	No. Subsidence is anticipated to only occur in the East Plant Site/Oak Flat area; these effects would be common to all action alternatives. Similarly, no geological or seismic activity of any kind is expected at any of the other proposed project facilities. All other alternatives also have non–Resolution Copper unpatented mining claims within either the tailings storage facility footprint or the tailings pipeline corridor.

SOILS AND VEGETATION — DEIS SECTION 3.3

Key factors to analyze the issue of soils and vegetation	What are the results of impact analysis for the proposed action (Alternative 2)?	Are the analyzed impacts of these issues substantially different under Alternatives 3, 4, 5, or 6?
• Acres of disturbance leading to lost soil productivity • Assessment of the potential for revegetation of tailings and other mine facilities, based on revegetation efforts conducted in central and southern Arizona • Evaluation of alteration of soil productivity and soil development • Assessment of impacts on special status vegetation species • Assessment of the potential to create conditions conducive for invasive species	All action alternatives, including Alternative 2, would result in impacts on endangered Arizona hedgehog cactus at the East Plant Site/subsidence area and possibly also at other project locations (see “Special Status Plant Species” in section 3.3.3.2 and “Construction/Operational Impacts” in section 3.3.4.2). Alternative 2 would remove or modify approximately 10,033 acres of vegetation and soils. Based on case studies in Arizona and New Mexico, a minimum of 8% of vegetation cover (including both native and non-native species) can consistently be established by year 10 within project disturbance areas (see “Expected Effectiveness of Reclamation Plans” in section 3.3.4.2). The revegetation response is expected to be influenced by the nature of the surface disturbance. Irrigation or active soil management could enhance revegetation success, thereby reducing erosional losses and net negative impacts on soil productivity. However, even with optimal soil management, impacts on soil health and productivity may last centuries to millennia; the ecosystem may not meet desired future conditions. Habitat may be suitable for generalist wildlife and plant species, but rare plants and wildlife with specific habitat requirements are unlikely to return (see “Potential to Achieve Desired Future Conditions” in section 3.3.4.2). The proposed project, under any action alternative, would increase the potential for noxious weed cover and possibly alter natural fire regimes. Reclamation of disturbed areas would decrease but not eliminate the likelihood of noxious weeds becoming established or spreading (see “Noxious Weeds” in section 3.3.4.2).	Yes. These discussions are applicable to all proposed and alternative tailings locations, but disturbance acreages would vary by alternative. Alternative 3: Same as Alternative 2 Alternative 4 would remove or modify approximately 10,861 acres of vegetation and soils. Alternative 5 would remove or modify approximately 17,153 to 17,530 acres of vegetation and soils, depending on pipeline route. Both the east and west pipeline corridor options would also impact critical habitat. The west pipeline option would disturb around 103 acres of Acuña cactus critical habitat, and the east pipeline option would disturb about 12 acres of critical habitat. Alternative 6 would remove or modify approximately 16,166 to 16,557 acres of vegetation and soils.

NOISE AND VIBRATION — DEIS SECTION 3.4

Key factors to analyze the issue of noise and vibration	What are the results of impact analysis for the proposed action (Alternative 2)?	Are the analyzed impacts of these issues substantially different under Alternatives 3, 4, 5, or 6?
• Assessment of the ability of alternatives to meet rural landscape expectations • Assessment of noise levels (A-weighted decibels [dBA]) and geographic area impacted from mine operations, blasting, and traffic, and qualitative assessment of effects of noise at nearby residences and sensitive receptors • Assessment of effects of vibrations from blasting and mine operations at nearby residences and sensitive receptors	Noise impacts were modeled for 15 sensitive receptors representing residential, recreation, and conservation land uses. Under most conditions, predicted noise and vibrations during construction and operations, for both blasting and non-blasting activities, at sensitive receptors are below thresholds of concern; rural character would not change due to noise (see section 3.4.4.2).	Yes. For Alternatives 3, 4, and 5, noise impacts are the same, with noise and vibration levels at sensitive receptors below thresholds of concern under most conditions. For Alternative 6, noise levels along Dripping Springs Road exceed thresholds of concern. However, there would be no residual impacts after mitigation is implemented (i.e., new routing of access road), therefore rural character would not be altered due to increased noise.

TRANSPORTATION AND ACCESS — DEIS SECTION 3.5

Key factors to analyze the issue of transportation and access	What are the results of impact analysis for the proposed action (Alternative 2)?	Are the analyzed impacts of these issues substantially different under Alternatives 3, 4, 5, or 6?
• Assessment of change in type and pattern of traffic by road and vehicle type • Assessment of the change in level of service (LOS) on potential highway routes and local roads • Assessment of roads decommissioned by the mine and roads lost to motorized access	Sixty-four trips expected during the peak hour in peak construction and 46 trips expected during the peak hour during normal operations. Project-related traffic would contribute to decreased LOS at many intersections; unacceptable LOS (E/F) caused by project-related traffic occurs at Silver King Mine Road/U.S. 60 (construction and operations), Main Street/U.S. 60 (construction and operations), SR 177/U.S. 60 (construction), and Magma Mine Road/U.S. 60 (operations). A total of 8.0 miles of NFS roads would be lost due to the West Plant Site, East Plant Site, and filter plant and loadout facility. For the tailings facility, 21.7 miles of NFS roads would be lost and decommissioned.	Yes. Alternatives 3, 5, and 6 would have similar impacts as Alternative 2, but Alternative 4 would increase to 88 trips expected during the peak hour in peak construction and 58 trips expected during the peak hour during normal operations, due to placing the filter plant and loadout facility at the West Plant Site. LOS impacts from project-related traffic are similar to Alternative 2 for all other alternatives. At Alternative 4, a total of 17.7 miles of NFS roads would be lost to the tailings storage facility. Alternative 5 would not have loss to NFS roads but would result in the loss or decommissioning of 29 miles of BLM inventoried routes. Alternative 6 would be located on private lands and impact 5.7 miles of Dripping Springs Road.

AIR QUALITY — DEIS SECTION 3.6

Key factors to analyze the issue of air quality	What are the results of impact analysis for the proposed action (Alternative 2)?	Are the analyzed impacts of these issues substantially different under Alternatives 3, 4, 5, or 6?
• Fugitive dust emissions • Stationary and mobile-source criteria air pollutant emissions and anticipated project conformance or non-conformance with National Ambient Air Quality Standards (NAAQS) • Conformance with the State Implementation Plan (SIP) in designated nonattainment and maintenance areas • Class I areas and air quality-related value impacts	Analysis finds that neither daily nor annual maximum impacts for fugitive dust ($PM_{2.5}$ and PM_{10}) would exceed established air quality thresholds; no predicted results for criteria pollutants are anticipated to exceed the NAAQS at the ambient air boundary/fence line (see “Air Quality Impact Assessment” in section 3.6.4.2). The Forest Service determined that no conformity analysis is warranted. While the East Plant Site would be partially located in the Hayden PM_{10} Nonattainment Area and the filter plant and loadout facility would be located in the West Pinal PM_{10} Nonattainment Area, modeling results demonstrate that the impacts from the proposed action and alternatives would not exceed ambient air quality standards for these areas, and PM_{10} emissions for stationary sources are well below the 100 tons/year threshold (see “Conformity” in section 3.6.3.2). Impacts are projected to be less than the PSD increments at all Class I areas but exceed 50% of the PM_{10} and $PM_{2.5}$ PSD increments at the Superstition Wilderness. Impacts on air quality-related values (deposition and visibility) would be within established thresholds for *de minimis* levels of acceptability (see “Impacts at Sensitive Areas” in section 3.6.4.2).	No. Emissions are largely similar between all alternatives, and no alternative is predicted to exceed NAAQS for criteria pollutants at the ambient air boundary/fence line.

WATER RESOURCES: GROUNDWATER QUANTITY AND GROUNDWATER-DEPENDENT ECOSYSTEMS (GDES) — DEIS SECTION 3.7.1

Key factors to analyze the issue of groundwater quantity and groundwater-dependent ecosystems	What are the results of impact analysis for the proposed action (Alternative 2)?	Are the analyzed impacts of these issues substantially different under Alternatives 3, 4, 5, or 6?
• Geographic extent in which water resources may be impacted and number of GDEs degraded or lost. • Impact on public groundwater supplies • Comparison of mine water needs • Potential for subsidence to occur as a result of groundwater withdrawal.	Under no action, six GDEs (all springs) are anticipated to be impacted by groundwater drawdown from ongoing dewatering (see “Alternative 1 – No Action” in section 3.7.1.4). When block-caving occurs, groundwater impacts expand to overlying aquifers and two more GDEs (springs) are anticipated to be impacted. Alternative 2 also directly disturbs five GDEs (all springs), and reductions in stormwater runoff impact three more GDEs (Devil’s Canyon and two reaches of Queen Creek). There are surface water rights associated with many of these GDEs. A total of 16 GDEs would be impacted by Alternative 2. Loss of water would be mitigated but impacts on natural setting would remain (see Alternative 2, “Groundwater-Dependent Ecosystems Impacted,” in section 3.7.1.4). Groundwater supplies in Superior and Top-of-the-World could be impacted by groundwater drawdown but would be replaced through mitigation (see “Anticipated Impacts on Water Supply Wells” in section 3.7.1.4). Over the mine life, Alternative 2 would dewater about 87,000 acre-feet from the mine and would require about 590,000 acre-feet of makeup water pumped from the Desert Wellfield. The wellfield pumping would incrementally contribute to ground subsidence in the East Salt River valley, and cumulatively reduce overall groundwater availability in the area (see ”Changes in Basin Water Balance – Mine Dewatering” and Alternative 2, “Changes in Desert Wellfield Pumping,” in section 3.7.1.4; and also see section 3.7.1.5).	Yes. There are differences between alternatives in the number of GDEs impacted and the amount of makeup water required. Alternative 3 would impact the same GDEs as Alternative 2 but would pump about 490,000 acre-feet from the Desert Wellfield over the mine life (see Alternative 3 in section 3.7.1.4). Alternative 4 would impact 14 GDEs (eight springs from groundwater drawdown, three springs from direct disturbance, and three stream reaches from reductions in stormwater runoff [Devil’s Canyon and two areas of Queen Creek]). Alternative 4 uses filtered tailings and would pump about 180,000 acre-feet from the Desert Wellfield over the mine life, much less than the other alternatives (see Alternative 4 in section 3.7.1.4). Alternative 5 would impact 14 GDEs (eight springs from groundwater drawdown, two springs from direct disturbance, and four stream segments from reductions in stormwater runoff [Devil’s Canyon, two areas of Queen Creek, and the Gila River]). Alternative 5 would pump about 540,000 acre-feet from the Desert Wellfield over the mine life (see Alternative 5 in section 3.7.1.4). Alternative 6 would impact the same GDEs and would pump about the same amount of water as Alternative 5 (see Alternative 6 in section 3.7.1.4).

WATER RESOURCES: GROUNDWATER AND SURFACE WATER QUALITY — DEIS SECTION 3.7.2

Key factors to analyze the issue of groundwater and surface water quality	What are the results of impact analysis for the proposed action (Alternative 2)?	Are the analyzed impacts of these issues substantially different under Alternatives 3, 4, 5, or 6?
• Anticipated groundwater and surface water quality changes, compared for context to Arizona water quality standards, in the block-cave zone and from tailings seepage • Anticipated surface water quality impacts from stormwater runoff • Assessment of seepage control techniques • Potential for a lake to develop in the subsidence crater • Reductions in assimilative capacity • Potential impacts on impaired waters • Assessment of the potential for processing chemicals, asbestos, or radioactive materials in tailings seepage	After closure, the reflooded block-cave zone is anticipated to have poor water quality (above Arizona water standards). No lake is anticipated to develop in the subsidence crater, and no other exposure pathways exist for this water (see “Potential for Subsidence Lake Development” in section 3.7.2.4). Stormwater runoff could have poor water quality but no stormwater contacting tailings or facilities is released during operations or post-closure until reclamation is successful and water meets appropriate standards (see “Potential Surface Water Quality Impacts from Stormwater Runoff” in section 3.7.2.4). Engineered seepage controls designed for Alternative 2 are modeled to capture 99% of seepage. No concentrations are above aquifer water quality standards; however, selenium concentrations in Queen Creek at Whitlow Ranch Dam are anticipated to be above surface water standards. There are substantial difficulties in adding additional seepage controls at this location; the risk for potential water quality problems is high (see Alternative 2, “Potential Water Quality Impacts from Tailings Storage Facility,” in section 3.7.2.4). Assimilative capacity for selenium in Queen Creek is used up by impact of tailings seepage. Queen Creek is impaired for copper, and copper load from tailings seepage inhibits watershed load reduction efforts (see “Potential Impacts on Impaired Waters” and “Predicted Reductions in Assimilative Capacity” in section 3.7.2.4). Analysis found little risk of processing chemicals, asbestos, or radioactive materials to persist in tailings or tailings seepage (see “Other Water Quality Concerns” in section 3.7.2.4).	Yes. All alternatives differ in engineered seepage controls, risk of water quality problems from tailings seepage, and impacts on downstream waters for assimilative capacity and impairment. Engineered seepage controls designed for Alternative 3 are modeled to capture 99.5% of seepage. This results in no concentrations above aquifer or surface water standards. Adding seepage controls at this location would be difficult, and risk for potential water quality problems high (see Alternative 3, “Potential Water Quality Impacts from Tailings Storage Facility,” in section 3.7.2.4). Engineered seepage controls designed for Alternative 4 are assumed (not modeled) to capture 90% of seepage. This results in no concentrations are above aquifer water quality standards; however, selenium concentrations in Queen Creek at Whitlow Ranch Dam are anticipated to be above surface water standards. Some potential exists to add seepage controls at this location, so risk of potential water quality problems is less than Alternatives 2 and 3 (see Alternative 4, “Potential Water Quality Impacts from Tailings Storage Facility,” in section 3.7.2.4). Engineered seepage controls designed for Alternative 5 are modeled to capture 84% of seepage. This results in no concentrations above aquifer or surface water standards. Alternative 5 also has substantial flexibility for adding other layers of seepage controls during operations as needed (see Alternative 5, “Potential Water Quality Impacts from Tailings Storage Facility,” in section 3.7.2.4). Engineered seepage controls designed for Alternative 6 are modeled to capture 90% of seepage. This results in no concentrations above aquifer or surface water standards. Alternative 6 also has substantial flexibility for adding other layers of seepage controls during operations as needed (see Alternative 6, “Potential Water Quality Impacts from Tailings Storage Facility,” in section 3.7.2.4).

WATER RESOURCES: SURFACE WATER QUANTITY — DEIS SECTION 3.7.3

Key factors to analyze the issue of surface water quantity	What are the results of impact analysis for the proposed action (Alternative 2)?	Are the analyzed impacts of these issues substantially different under Alternatives 3, 4, 5, or 6?
• Assessment of the change in volume, frequency, and magnitude of runoff from the project area, as it affects Devil's Canyon, Queen Creek, and the Gila River • Acres of 100-year floodplains impacted • Acres of wetland impacted, based on National Wetlands Inventory • Acres of potentially jurisdictional waters of the U.S. (Clean Water Act 404 permit) • Potential changes in downstream geomorphology and sediment yield	There would be a reduction in average annual runoff due to the subsidence crater capturing precipitation, amounting to 3.5% at the mouth of Devil's Canyon, and 3.5% in Queen Creek at Whitlow Ranch Dam. The Alternative 2 tailings storage facility also captures precipitation, resulting in a combined loss in Queen Creek at Whitlow Ranch Dam of 6.5% (see Alternative 2, "Impacts on Surface Runoff and Streamflow," in section 3.7.3.4). Alternative 2 impacts 8.5 acres of floodplain (though Federal Emergency Management Agency [FEMA] coverage is incomplete), 98.6 acres of wetlands in the National Wetlands Inventory (94% of these are xeroriparian/ephemeral washes), and zero acres of impacts of jurisdictional waters (the USACE gave an approved delineation to Resolution Copper in 2015 that indicates waters upstream of Whitlow Ranch Dam are not considered jurisdictional; see Alternative 2 in section 3.7.3.4). Geomorphology and sediment impacts in downstream waters are unlikely to change for any alternative, due to nature of ephemeral washes and stormwater controls (see "Impacts on Sediment Yields and Geomorphology of Streams" in section 3.7.3.4).	Yes. Alternative 3 is identical to Alternative 2, but surface flow reductions, floodplains, wetlands, and waters of the U.S. differ for Alternatives 4 through 6. Alternative 4 results in an 8.9% combined loss of average annual runoff in Queen Creek at Whitlow Ranch Dam and 19.9% loss in Queen Creek at Boyce Thompson Arboretum. Alternative 4 impacts the same floodplains as Alternative 2, 90.5 acres of wetlands in the National Wetlands Inventory (95% of these are xeroriparian/ephemeral washes), and zero acres of impacts on jurisdictional waters (see Alternative 4 In section 3.7.3.4). Alternative 5 results in a 0.2% loss of average annual runoff in the Gila River at Donnelly Wash. Alternative 5 impacts up to 171 acres of floodplains (varies by pipeline route), up to 228.6 acres of wetlands in the National Wetlands Inventory (96% are xeroriparian/ephemeral washes), and 182.5 acres of potentially jurisdictional waters of the U.S. (Alternatives 5 and 6 are not in the Queen Creek drainage, unlike Alternative 2; see Alternative 5 in section 3.7.3.4). Alternative 6 results in a 0.5% loss of average annual runoff in the Gila River at Dripping Spring Wash and 0.3% in the Gila River at Donnelly Wash. Alternative 6 impacts 794 acres of mapped floodplain, up to 274 acres of wetlands in the National Wetlands Inventory (85% are xeroriparian/ephemeral washes), and 120 acres of potentially jurisdictional waters (see Alternative 6 in section 3.7.3.4).

WILDLIFE AND SPECIAL STATUS WILDLIFE SPECIES — DEIS SECTION 3.8

Key factors to analyze the issue of wildlife	What are the results of impact analysis for the proposed action (Alternative 2)?	Are the analyzed impacts of these issues substantially different under Alternatives 3, 4, 5, or 6?
• Assessment of effects on riparian habitat and species due to changes in flow • Assessment of acres of suitable habitat disturbed for each special status species and by type of terrestrial and aquatic habitat lost, altered, or indirectly impacted • Potential of mortality of animal species resulting from the increased volume of traffic related to mine operations • Effects on wildlife behavior from noise, vibrations, and light • Change in movement corridors and connectivity between wildlife habitats • Impacts on aquatic habitats and surface water that support wildlife and plants	Alternative 2 would impact 16 groundwater-dependent ecosystems (GDEs). For the springs or stream segments impacted by groundwater drawdown or surface water flow reductions, mitigation would replace the water source and prevent widespread loss of riparian habitat. The remaining GDEs are lost to surface disturbance and would not be mitigated. Loss of xeroriparian habitat occurs for all alternatives. Habitat would be impacted to some extent for 50 special status wildlife species (see table 3.8.4.2 for details). Specific impacts could occur with western yellow-billed cuckoo (endangered) and southwestern willow flycatcher (endangered) from vegetation removal or project activities. Gila chub (endangered) has critical habitat along Mineral Creek but is not known to be present and habitat in Mineral Creek is not anticipated to be impacted (see “Impacts on Special Status Wildlife Species” in section 3.8.4.2). There is a high probability of mortality and/or injury of wildlife individuals from collisions with mine construction and employee vehicles as well as the potential mortality of burrowing animals in areas where grading would occur. Some individuals would be likely to move away from the sources of disturbance to adjacent or nearby habitats. Project-related noise, vibration, and light may also lead to increased stress on individuals and alteration of feeding, breeding, and other behaviors (see “General Construction Impacts” and “General Operations Impacts” in section 3.8.4.2). There would be loss and fragmentation of movement and dispersal habitats from the subsidence area and tailings storage facility. Ground-clearing and consequent fragmentation of habitat blocks for other mine-related facilities would also inhibit wildlife movement (see “Wildlife Connectivity” in section 3.8.4.2). There are 15 identified wildlife waters within 5 miles of the project footprint. Under Alternative 2, three would be lost beneath the tailings storage facility.	Yes. Alternative 3 is similar to Alternative 2. Alternative 4 would have more reduction in surface flow and greater impacts on Queen Creek. Alternatives 5 and 6 would have less impact on Queen Creek due to surface flow reductions. A total of 14 GDEs and 2 wildlife waters would be impacted under Alternatives 4, 5, and 6. Specific acres of habitat affected varies between alternatives (see table 3.8.4.2 for details). Alternative 6 (north and south tailings corridor options) would impact the greatest amount of acreage for Habitat Block 1 areas.

RECREATION — DEIS SECTION 3.9

Key factors to analyze the issue of recreation	What are the results of impact analysis for the proposed action (Alternative 2)?	Are the analyzed impacts of these issues substantially different under Alternatives 3, 4, 5, or 6?
• Changes in Recreation Opportunity Spectrum designations • Assessment of acres of the Tonto National Forest that would be unavailable for recreational use, for various phases of mine life and reclamation • Assessment of potential for noise to reach recreation areas (i.e., audio "footprint") • Assessment of impacts on solitude in designated wilderness and other backcountry areas • Assessment of hunter-days lost (quantity based on number of permits available and number of days in season) • Assessment of miles of Arizona National Scenic Trail, NFS trails, or other known trails requiring relocation, and qualitative assessment of user trail experience • Assessment of increased pressure on other areas, including roads and trails/trailheads, from displacement and relocation of recreational use as a result of mine facilities	Under Alternative 2, based on the Recreation Opportunity Spectrum (ROS) designation of user experiences, direct removal of 5,288 acres of the semi-primitive motorized setting, and 2,215 acres within the roaded natural setting (see table 3.9.4-1). All public access would be eliminated on 4,933 acres. Rock climbing opportunities at Euro Dog Valley, Oak Flat, and other portions of the mine area would be lost under all action alternatives but would be partially mitigated by new climbing area(s) set aside by Resolution Copper (see "Rock Climbing" in section 3.9.4.2). Under most conditions, with sensitive receptors representing recreation users, predicted noise during construction and operation are below thresholds of concern (see Alternative 2, "Recreation Opportunity Spectrum," in section 3.9.4.3). Visitors to the Superstition Wilderness, Picketpost Mountain, and Apache Leap would have foreground and background views of the tailings facilities from trails and overlooks, and the recreation setting from certain site-specific views could change. Under Alternative 2, 0.07 mile of the tailings pipeline corridor would intersect the Arizona Trail (see Alternative 2, "Recreation Sites," in section 3.9.4.3). The number of Arizona hunting permits that are issued in individual Game Management Units would not change as a result of the any of the action alternatives being implemented, though some individual's preferred hunting grounds may be lost (see "Hunting" in section 3.9.4.2). Under all action alternatives, it is likely that increased use would occur on other nearby lands that provide similar experiences, depending upon the recreational user type. A minor to moderate increase in user activity would be expected to occur in recreational use areas elsewhere, with uses largely similar to those displaced.	Yes. Alternative 3 is identical to Alternative 2. Alternative 4 would remove 5,548 acres of the semi-primitive motorized setting and 2,078 acres within the roaded natural setting. Alternative 4 would require 3.05 miles of the Arizona Trail to be closed and relocated to an area that would be safe for public use. Under Alternative 4, 26 NFS roads would be impacted for motorized recreation. Alternative 5 (east option) would remove 986 acres of the semi-primitive motorized setting, 1,209 acres of the semi-primitive non-motorized setting, and 1,977 acres of the roaded natural setting. Alternative 5 (west option) would remove 1,173 acres of the semi-primitive motorized setting, and 1,453 acres of the roaded natural setting. Under Alternative 5, 23 miles of BLM routes would be impacted for motorized recreation, and additional BLM and NFS roads would be crossed by the pipeline. Alternative 5 would intersect the Passage 16 segment of the Arizona Trail by 0.18 mile of the proposed tailings storage facility east pipeline. Visitors to the White Canyon Wilderness would have background views of the Alternative 5 east pipeline from some trails and overlooks. Alternative 6 (north option) would remove 1,665 acres of the semi-primitive motorized setting, and 1,740 acres of the roaded natural setting. Alternative 6 (south option) would remove 1,617 acres of the semi-primitive motorized setting, and 2,054 acres of roaded natural setting. Under Alternative 6, no BLM or NFS roads are within the footprint, although roads are crossed by the pipeline. The Alternative 6 south pipeline would be visible from trails and overlooks on Picketpost Mountain and the north pipeline from Superstition Wilderness.

PUBLIC HEALTH AND SAFETY: TAILINGS AND PIPELINE SAFETY — DEIS SECTION 3.10.1

Key factors to analyze the issue of tailings and pipeline safety	What are the results of impact analysis for the proposed action (Alternative 2)?	Are the analyzed impacts of these issues substantially different under Alternatives 3, 4, 5, or 6?
• Qualitative assessment of the risk of failure of tailings embankment or concentrate/tailings pipelines and potential impacts downstream in the event of a failure	Risk of failure of all alternatives is minimized by required adherence to National Dam Safety Program and APP standards, and applicant-committed environmental protection measures (see "Federal Requirements for Tailings Facility Design" in section 3.10.1.3). Failure of a slurry tailings facility has historically been demonstrated to have the potential to runout tailings dozens or even hundreds of miles downstream. Consequences of a catastrophic failure at the Alternative 2 tailings storage facility would include possible loss of life and limb, destruction of property, and displacement of large populations with a downstream population of over 600,000, including Queen Valley, within a few miles downstream. A catastrophic failure would disrupt the Arizona economy, would result in contamination of soils and water, and would jeopardize water supplies for over 700,000 people and key water infrastructure like the CAP canal (see 3.10.1.4, Alternative 2). Consequences of a concentrate or tailings pipeline failure would include soil and water contamination and destruction of vegetation in any water bodies crossed. The Alternative 2 embankment is less resilient than Alternatives 5 and 6 due to: • modified-centerline construction instead of centerline construction • a long embankment (10 miles) • a freestanding structure • the potential to release PAG materials during a failure	Yes. While all built to the same standards, the alternatives differ in downstream environment and resilience of the design. Alternative 3 is similar to Alternative 2, but the design is more resilient because of the use of ultrathickened tailings (see Alternative 3 in section 3.10.1.4). Alternative 4 is fundamentally different from the other action alternatives. As a filtered tailings facility, if Alternative 4 were to fail, it would likely fail as an earth slump or landslide, impacting only several miles of xeroriparian wash and not jeopardizing life and limb, property, or water supplies (see Alternative 4 in section 3.10.1.4). Alternative 5 has smaller downstream populations (32,000), with no major population center for 20 miles. The Gila River Indian Community and substantial agricultural water supplies are downstream. Alternative 5 facility is more resilient than Alternatives 2 and 3 due to: centerline construction, a slightly shorter embankment (7 miles), and storage of PAG in separate cells that use downstream embankments (see Alternative 5 in section 3.10.1.4). Alternative 6 has the smallest downstream population (3,200) but with a population center just downstream. The Alternative 6 facility is more resilient than Alternatives 2, 3, or 5 due to: centerline construction, the shortest embankment (3 miles), cross-valley construction, and storage of PAG in separate cells that use downstream embankments (see Alternative 6 in section 3.10.1.4).

PUBLIC HEALTH AND SAFETY: FUELS AND FIRE MANAGEMENT — DEIS SECTION 3.10.2

Key factors to analyze the issue of fuels and fire management	What are the results of impact analysis for the proposed action (Alternative 2)?	Are the analyzed impacts of these issues substantially different under Alternatives 3, 4, 5, or 6?
• Potential for increased fire risk due to mine operations (i.e., inadvertent ignition) • Potential for increased fuelwood loads in the Oak Flat area as a result of subsidence and dewatering • Adequacy of Forest Service and municipal fire teams and equipment to respond to wildfires	Wildland fire is always a risk, particularly in areas where human activities and greater densities of standing and fallen vegetation intersect (areas, for example, such as Oak Flat). It is assumed that MSHA regulations, Resolution Copper's own internal policies, as well as Forest Service and Pinal County–announced fire risk alerts and restrictions during periods of drier conditions and higher winds, would serve to prevent most cases of inadvertent, human-caused ignition (see section 3.10.2.4). While some increase in dead and dying vegetation within the subsidence area may be expected, other plants may be expected to persist and still others to reestablish within the area, particularly once active subsidence ceases. The risk of human-caused ignitions in the subsidence area is effectively negligible because the area would be fenced off and no entry would be permitted. Die-off of riparian vegetation is not anticipated as a consequence of dewatering in the Oak Flat area generally, because agreed-upon mitigation measures would ensure replacement water in these areas. Wildland fire response in and adjacent to the project areas would be provided by local fire department personnel such as those from the Town of Superior. The Tonto National Forest, BLM, and Pinal County also provide support for initial wildland fire attack for areas within and adjacent to wildland–urban interface (WUI) areas, while the Arizona Department of Forestry and Fire Management is responsible for suppression of wildland fire on State Trust land and private property located outside incorporated communities. Historically, these assets and accompanying wildland fire control strategies have been considered adequate; it should be noted, however, that fire response resources tend to become limited during the height of the annual fire season due to commitments elsewhere in the state (see "Wildfire Response" in section 3.10.2.3).	Yes. While under any of the alternatives, the risk of inadvertent ignition and resulting wildland fire is considered quite low, Alternative 4 includes areas classified with shrub fuels (SH7) that burn with high intensity in the event of an ignition. Intense fire behavior was observed within the footprint of Alternative 4 during the Peachville Fire, which burned a portion of the proposed tailings area in 2005. In addition, the southern portion of the footprint for Alternative 4 is located within the WUI for the town of Superior, meaning this location could potentially expose life and property to wildfire impacts should an ignition occur. On the other hand, because of the close proximity to Superior, fire response to the area should be rapid with emergency services provided by both the Tonto National Forest and the Town of Superior (see section 3.10.2.4).

PUBLIC HEALTH AND SAFETY: HAZARDOUS MATERIALS — DEIS SECTION 3.10.3

Key factors to analyze the issue of hazardous materials	What are the results of impact analysis for the proposed action (Alternative 2)?	Are the analyzed impacts of these issues substantially different under Alternatives 3, 4, 5, or 6?
• Amount, type, location of storage, use, and disposal of hazardous materials and potential for release to the environment • Transportation of hazardous materials to the project area and potential for release to the environment • Fate and transport of different types of hazardous materials if they enter the environment	The Resolution Copper GPO and appendix G of the EIS provide information on the company's expected use of various chemicals and other hazardous materials in its mining and processing operations. MSHA and other regulations and standards govern the transport and storage of explosives and hazardous chemicals; risks of spills or releases are therefore considered possible, but unlikely. Potential releases of hazardous materials during transportation could occur, but the fate and transport of those hazardous materials depend entirely on where the release occurs and the quantity of the release. The company would be required by various local, State, and Federal regulations to maintain spill prevention, control, and emergency response plans.	No. See section 3.10.3.4.

SCENIC RESOURCES — DEIS SECTION 3.11

Key factors to analyze the issue of scenic resources	What are the results of impact analysis for the proposed action (Alternative 2)?	Are the analyzed impacts of these issues substantially different under Alternatives 3, 4, 5, or 6?
• Acres of Tonto National Forest that would no longer meet current forest plan Visual Quality Objective designations • Anticipated changes in landscape character from key analysis viewpoints, for various phases of mine life and reclamation • Miles of project area visibility along major thoroughfares in the area (i.e., U.S. 60, SR 79, and SR 177) • Potential for increase in sky brightness resulting from the mine facility and mine-related vehicle lighting	Analysis finds that within the project footprint the following acreage totals have designations that would not allow for the proposed project activities: 393 acres of Retention, and 5,184 acres of Partial Retention (see table 3.11.4-2). The analysis of anticipated changes in landscape character from key analysis viewpoints for Alternative 2 is too extensive to summarize here and is presented in tables 3.11.4-1, 3.11.4-3, 3.11.4-4, and 3.11.4-5. Analysis shows that Alternative 2 facilities would be visible along 21.2 miles of U.S. 60 and 2.5 miles of SR 177 (see table 3.11.4-4). Lighting at the East Plant Site, West Plant Site, and tailings facility would be visible and noticeable at night from the town of Superior, U.S. 60, Boyce Thompson Arboretum, the Arizona Trail, and the surrounding national forest landscape (see Alternative 2, "Dark Skies," in section 3.11.4.1).	Yes. Under Alternative 4, analysis finds that within the project footprint the following acreage totals have designations that would not allow for the proposed project activities: 371 acres of Retention, and 4,663 acres of Partial Retention (see table 3.11.4-2). Analysis of anticipated changes in landscape character for Alternative 4 is presented in tables 3.11.4-6 and 3.11.4-7. Alternative 4 facilities would be visible along 18.3 miles of U.S. 60 and 3.6 miles of SR 177 (see table 3.11.4-6). Under Alternative 5, analysis finds that within the project footprint the following acreage totals have designations that would not allow for the proposed project activities: 691 (east) or 530 (west) acres of Retention, and 1,905 (east) or 1,824 (west) acres of Partial Retention (see table 3.11.4-2). Analysis of anticipated changes in landscape character for Alternative 5 is presented in tables 3.11.4-8 and 3.11.4-9. Alternative 5 facilities would be visible along 1.5 miles of U.S. 60 and 1.5 miles of SR 177 (see table 3.11.4-8). Under Alternative 6, analysis finds that within the project footprint the following acreage totals have designations that would not allow for the proposed project activities: 676 (north) or 771 (south) acres of Retention, and 2,043 (north) or 2,225 (south) acres of Partial Retention (see table 3.11.4-2). Analysis of anticipated changes in landscape character for Alternative 6 is presented in table 3.11.4-10. Dark sky impacts are similar among alternatives.

CULTURAL RESOURCES — DEIS SECTION 3.12

Key factors to analyze the issue of cultural resources	What are the results of impact analysis for the proposed action (Alternative 2)?	Are the analyzed impacts of these issues substantially different under Alternatives 3, 4, 5, or 6?
• Assessment of the impacts on places of traditional and cultural significance to Native Americans, including natural resources • Assessment of number of NRHP-eligible historic properties, sacred sites, and other landscape-scale properties to be buried, destroyed, or damaged • Assessment of impacts on historic properties, including number of NRHP-eligible historic properties expected to be visually impacted	The NRHP-listed *Chí'chil Biłdagoteel* Historic District TCP would be directly and permanently damaged. Under Alternatives 2 and 3, 101 NRHP-eligible sites and 31 sites of undetermined eligibility would be directly affected; another 29 sites would be indirectly affected (see "Direct Impacts" and "Indirect Impacts" in section 3.12.4.3). Additional historic properties and archaeological sites are located within 6 miles of the proposed project and could be impacted by their proximity to mining disturbance (see "Atmospheric Impacts" in section 3.12.4.3).	Under any action alternative, impacts of mine development at the associated project facilities would have equivalent adverse effects on cultural resources. Some surveys continue; all alternatives will be 100% pedestrian surveyed. For Alternative 4, 122 NRHP-eligible sites and 15 sites of undetermined eligibility would be directly affected; another 25 sites would be indirectly affected (see section 3.12.4.5). For Alternative 5 east option, 125 NRHP-eligible sites and 27 sites of undetermined eligibility would be directly affected; another 44 sites would be indirectly affected (see section 3.12.4.6). For Alternative 5 west option, 114 NRHP-eligible sites and 11 sites of undetermined eligibility would be directly affected; another 29 sites would be indirectly affected (see section 3.12.4.6). For Alternative 6 north option, 318 NRHP-eligible sites and 5 sites of undetermined eligibility would be directly affected depending on pipeline route; another 25 additional sites would be indirectly affected (see section 3.12.4.7). For Alternative 6 south option, 343 NRHP-eligible sites and 17 sites of undetermined eligibility would be directly affected depending on pipeline route; as another 41 additional sites would be indirectly affected (see section 3.12.4.7).

SOCIOECONOMICS — DEIS SECTION 3.13

Key factors to analyze the issue of socioeconomics	What are the results of impact analysis for the proposed action (Alternative 2)?	Are the analyzed impacts of these issues substantially different under Alternatives 3, 4, 5, or 6?
• Assessment of potential changes in employment, labor earnings, and area economic output as a result of the Resolution Copper Mine, including direct and indirect economic effects • Assessment of changes to tax revenues; potential increased need for road maintenance and local emergency services; potential changes in tourism and recreation; potential effects on property values	On average, the mine is projected to directly employ 1,500 workers, pay about $134 million per year in total employee compensation, and purchase about $546 million per year in goods and services. Including direct and multiplier effects, the proposed mine is projected to increase average annual economic value added in Arizona by about $1 billion (see “Impact on Employment, Earnings, and Value Added” under “Socioeconomic Impacts” in section 3.13.4.2). The proposed mine is projected to generate an average of between $88 and $113 million per year in state and local tax revenues and would also produce substantial revenues for the Federal Government, estimated at over $200 million per year (see “State and Local Government Revenue Summary” under “Socioeconomic Impacts” in section 3.13.4.2). Construction and operations of the proposed mine could affect both the Town of Superior’s costs to maintain its network of streets and roads as well as those of Pinal County. A number of agreements between Resolution Copper and the Town of Superior would offset impacts on quality of life, education, and emergency services (see “Mine-Related Demands and Costs for Public Services” under “Socioeconomic Impacts” in section 3.13.4.2). Property values are expected to decline in close proximity to the tailings storage facilities and are estimated to average 4.1% under Alternative 2 (see “Potential Property Value Effects” under “Socioeconomic Impacts” in section 3.13.4.2). Loss of hunting revenue due to the tailings storage facility is expected to be greatest under Alternative 2 (see “Potential Effects on the Nature-Based Tourism Economy” under “Socioeconomic Impacts” in section 3.13.4.2).	Yes. Socioeconomic effects under any of the action alternatives are anticipated to be fundamentally the same as Alternative 2, except for property values and hunting revenue. Property values are expected to decline 10.6% under Alternative 4; approximately 6.3% under Alternative 5; and about 4.0% under Alternative 6 (see table 3.13.4-5). Loss of hunting revenue is similarly high under Alternative 4, and lowest under Alternative 5. Being private and State lands, hunting effects have yet to be determined for Alternative 6.

TRIBAL VALUES AND CONCERNS — DEIS SECTION 3.14

Key factors to analyze the issue of tribal values and concerns	What are the results of impact analysis for the proposed action (Alternative 2)?	Are the analyzed impacts of these issues substantially different under Alternatives 3, 4, 5, or 6?
• Assessment of how cumulative resource disturbance impacts tribal values and spiritual practices • Assessment of number of sacred springs or other discrete sacred sites that would be impacted, and potential effects on Native Americans from the desecration of land, springs, burials, and sacred sites • Estimated acres of traditional resource collection areas that would be impacted	Development of the Resolution Copper Mine would directly and permanently damage the NRHP-listed *Chí'chil Biłdagoteel* Historic District TCP. Other large-scale mine development along with smaller transportation, utility, and private land development projects in the greater Superior region may also affect places and resources of value to Native Americans, including historical and ceremonial sites and culturally valued landforms and features. Dewatering or direct disturbance would impact between 14 and 16 groundwater dependent ecosystems, mostly sacred springs. While mitigation would replace water, impacts would remain to the natural setting of these places. Burials are likely to be impacted; the numbers and locations of burials would not be known until such sites are detected as a result of mine-related activities. Under this or any action alternative, one or more Emory oak groves at Oak Flat, used by tribal members for acorn collecting, would likely be lost. Other unspecified mineral- and/or plant-collecting locations would also likely be affected; historically, medicinal and other plants are frequently gathered near springs and seeps, so drawdown of water at these locations may also adversely affect plant availability.	Under any action alternative, impacts of mine development at the East Plant Site (Oak Flat), West Plant Site, MARRCO corridor, and at other ancillary facilities would have equivalent adverse effects on tribal values and concerns. Impacts on tribal values and concerns would be similar in context and intensity under Alternatives 4, 5, and 6; however, because the tailings storage facility under each of these alternatives would be in a different location, the specific impacts on potentially meaningful sites, resources, routes, and viewsheds would vary. See sections 3.11.4 (Scenic Resources), 3.12.4 (Cultural Resources), and 3.14.4 (Tribal Values and Concerns) for detailed impact analyses specific to each alternative.

ENVIRONMENTAL JUSTICE — DEIS SECTION 3.15

Key factors to analyze the issue of environmental justice	**What are the results of impact analysis for the proposed action (Alternative 2)?**	**Are the analyzed impacts of these issues substantially different under Alternatives 3, 4, 5, or 6?**
• Potential for disproportionate economic effects on identified environmental justice communities in the analysis area (see “Potential Effects on Environmental Justice Communities by Resource” in section 3.15.4.3)	Environmental justice communities identified in the analysis area include eight identified Native American communities, as well as • town of Hayden, • town of Miami, • city of Globe, • town of Superior, and • town of Winkelman. Economic effects from the mine would be most apparent in the environmental justice community of the town of Superior due to its immediate proximity to Resolution Copper Project operations. While mine-induced beneficial economic activity would be expected to increase in the region generally, the expected influx of new workers may also lead to shortages of area housing and/or pressures on municipal infrastructure such as roads, schools, and medical facilities, and may be accompanied by price increases. Such changes would be most likely to adversely affect low-income and minority individuals in the town of Superior and other environmental justice communities in the region. Environmental effects in the immediate area such as increased traffic, noise, increased potential exposure to hazardous material spills or releases, as well as loss of certain recreational opportunities and changes to area scenic resources, are anticipated to occur, but would affect everyone equally and would therefore not be disproportionate.	No. Anticipated impacts on the environmental justice communities identified in the analysis area are not anticipated to vary by alternative, with the town of Superior having the most apparent effects.

LIVESTOCK AND GRAZING — DEIS SECTION 3.16

Key factors to analyze the issue of livestock and grazing	What are the results of impact analysis for the proposed action (Alternative 2)?	Are the analyzed impacts of these issues substantially different under Alternatives 3, 4, 5, or 6?
• Potential for changes to acreages of grazing allotments; potential for loss of grazing-related facilities (waters, stock tanks, roads, fences, etc.); and potential for changes to available animal unit months (AUMs) within individual grazing allotments (see section 3.16.4.2).	Under Alternative 2, affected grazing allotments would experience a reduction of 8,572 acres and 666 AUMs over six allotments and 25 grazing-related facilities would also be lost (see Alternative 2 in section 3.16.4.2).	Yes. Although acreage changes to grazing allotments would be identical under Alternatives 2 and 3, Alternatives 4, 5, and 6 would be different. Alternative 4: There would be a reduction in 9,399 acres and 737 AUMs over six allotments, and 24 grazing-related facilities would be lost (see Alternative 4 in section 3.16.4.2). Alternative 5: For the east pipeline corridor: There would be a reduction in 15,672 acres and 1,378 AUMs over 10 allotments, and 14 grazing-related facilities would be lost (see Alternative 5 in section 3.16.4.2). For the west pipeline corridor: There would be a reduction in 16,186 acres and 2,380 AUMs over 12 allotments, and 14 grazing-related facilities would be lost (see Alternative 5 in section 3.16.4.2). Alternative 6: For the north pipeline corridor: There would be a reduction of 14,747 acres and 2,674 AUMs over nine allotments, and 21 grazing-related facilities would be lost (see Alternative 6 in section 3.16.4.2). For the south pipeline corridor: There would be a reduction in 15,209 acres and 2,745 AUMs over nine allotments, and 21 grazing-related facilities would be lost (see Alternative 6 in section 3.16.4.2).

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CHAPTER 3

Overview

Chapter 3 describes the natural and human environment that may be affected by the proposed action and its alternatives, and discloses the direct, indirect, and cumulative impacts that could occur because of the proposed action or alternatives.

Direct and indirect impacts are those caused by the project itself. Cumulative impacts take into account not just the direct and indirect impacts of the proposed action (or alternatives), but also the combined effects of other past, present, and reasonably foreseeable future actions. These actions may have individually minor effects but become significant when combined. In most cases past and present actions, including ongoing trends, are part of the description of the affected environment.

Affected Environment and Environmental Consequences

3.1 Introduction

Each of the following sections in chapter 3 focuses on a specific resource, describes the environment that may be affected by the proposed action and its alternatives, and describes the direct, indirect, and cumulative impacts that could occur for that resource.

"Geology, Minerals, and Subsidence" (section 3.2) describes known geological characteristics at each of the major facilities of the proposed mine—including alternative tailings storage locations—and how the development of the project may impact existing cave and karst features, paleontological resources, area seismicity and other geological hazards, and mining claims. It also outlines subsidence impacts that would result from Resolution Copper's plans to extract the ore from below the deposit using a mining technique known as "block caving" or "panel caving" and describes how subsidence would affect Apache Leap.

"Soils and Vegetation" (section 3.3) explains how the proposed mine would disturb large areas of ground and potentially destroy native vegetation, including species given special status by the Forest Service, and encourage noxious or invasive weeds. This section also discusses reclamation plans and expected reclamation success.

"Noise and Vibration" (section 3.4) provides a detailed analysis of estimated impacts from noise and vibration under the proposed mining plan and each of the alternatives, including blasting impacts.

"Transportation and Access" (section 3.5) discusses how the proposed Resolution Copper Mine would increase traffic on local roads and highways and likely alter local and regional traffic patterns and levels of service. NFS road closures, along with accelerated deterioration of local roadways as a result of increased use, are examined.

"Air Quality" (section 3.6) analyzes potential impacts from an increase in dust, wind-borne particulate, and transportation-related emissions as a result of construction, mining, and reclamation activities at the mine. It also assesses how those emissions affect distant sensitive areas like the Superstition Wilderness.

"Water Resources" analyzes how the Resolution Copper Project could affect water availability and quality in three key areas: groundwater quantity and groundwater-dependent ecosystems (section 3.7.1); groundwater and surface water quality (section 3.7.2); and surface water quantity (3.7.3). This includes analysis of the impacts of dewatering at the mine site, analysis of pumping from the Desert Wellfield for the mine water supply, and anticipated effects from tailings seepage.

"Wildlife and Special Status Wildlife Species" (section 3.8) describes how impacts on wildlife can occur from habitat loss and fragmentation as well as from artificial lighting, noise, vibration, traffic, loss of water sources, or changes in air or water quality.

"Recreation" (section 3.9) describes the anticipated changes to some of the area's natural features

and recreational opportunities as a result of infrastructure development related to the project.

"Public Health and Safety" addresses three areas of interest: tailings and pipeline safety (section 3.10.1), fire risks (section 3.10.2), and the potential for releases or public exposure to hazardous materials (section 3.10.3).

"Scenic Resources" (section 3.11) addresses the existing conditions of scenic resources (including dark skies) in the area of the proposed action and alternatives, along with the potential changes to those conditions from construction and operation of the proposed project.

"Cultural Resources" (section 3.12) analyzes potential impacts on all known cultural resources within the project area.

"Socioeconomics" (section 3.13) examines the social and economic impacts on the quality of life for neighboring communities near the proposed mine.

"Tribal Values and Concerns" (section 3.14) discusses the high potential for the proposed mine to directly, adversely, and permanently affect numerous cultural artifacts, sacred seeps and springs, traditional ceremonial areas, resource gathering localities, burial locations, and other places and experiences of high spiritual and other value to tribal members.

"Environmental Justice" (section 3.15) examines issues related to the project that have the potential to harm vulnerable or disadvantaged communities.

"Livestock and Grazing" (section 3.16) describes the loss to public use of Federal and State lands—including livestock grazing—from implementation of the proposed action or alternatives.

The analyses contained in chapter 3 were developed from issues identified during the scoping process. The relevant issues are only briefly recapped in chapter 3. The reader is directed to chapter 1, appendix E, or the November 2017 report titled "Resolution Copper Project and Land Exchange Environmental Impact Statement: Final Summary of Issues Identified Through Scoping Process" (Issues Report) for full details (SWCA Environmental Consultants 2017b). The geographic area included for analysis is unique to each resource and encompasses areas in which direct or indirect impacts would be expected to occur. The anticipated impacts on each resource are analyzed for all phases of the project (construction, operation, and post-closure); in some cases, the analysis may focus on the time period that would cause the maximum impact on that resource.

As with the issues, for brevity's sake, several other discussions in the EIS are only summarized, with the full details found elsewhere. For "Analysis Methodology, Assumptions, and Uncertain and Unknown Information," the intent is to provide enough information in the EIS for the reader to understand what tools were chosen for the analysis and any limitations of those tools. For "Relevant Laws, Regulations, Policies, and Plans," the intent is to briefly list the most pertinent items for the reader. Most of this information is captured in a detailed memorandum for the project record; a guide to the additional information available in these memoranda is included in appendix K.

The "Affected Environment" section describes the existing conditions for the resource. Existing conditions include effects of past, present, and ongoing actions that are occurring or have occurred within the analysis area.

The "Environmental Consequences" section describes the impacts of the proposed action or alternatives on the environment. Impacts include both the direct effects and indirect effects of the proposed action or alternatives. Direct effects are caused by the action and occur at the same time and in the same place. Indirect effects are caused by the action and are later in time and/or farther removed in distance but are still reasonably foreseeable (40 CFR 1508.8). Where alternatives have similar (though not necessarily identical) impacts, all alternatives may be discussed together, to be followed if needed by a discussion of the impacts that differ substantially between the alternatives.

The "Environmental Consequences" section also describes the cumulative impacts of the proposed action or alternatives. CEQ regulations define a cumulative impact as one that "results from the incremental impact of the action when added to other past, present,

and reasonably foreseeable actions, regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time" (40 CFR 1508.7).

Cumulative impacts are the combination of impacts from the proposed action or alternatives with other past, present, or reasonably foreseeable future actions. Past and present actions contribute to the existing condition of the affected environment in the project area and are included under the "Affected Environment" heading. The additional effects of the proposed action or alternatives are discussed under the "Environmental Consequences" heading. To assess cumulative impacts, those effects must then be considered in conjunction with the effects of "reasonably foreseeable" future actions, as long as they overlap in both space and time.

A "reasonably foreseeable" action is one that is likely to occur in the future and does not include those that are speculative. The Forest Service compiled a list of future actions to form the basis for the cumulative effects analysis and applied specific criteria to determine whether they were reasonably foreseeable or speculative (Rigg and Morey 2018). Only the effects of those actions determined to be reasonably foreseeable, and to overlap spatially and temporally with effects from the proposed action or alternatives, are included in the "Cumulative Effects" section of each resource (SWCA Environmental Consultants 2018a).

As described in chapter 2, the Forest Service is in the process of developing a comprehensive set of mitigation measures that, where practical and technically feasible to implement, would serve to avoid, minimize, rectify, reduce, or compensate for resource impacts identified during effects analyses conducted for this EIS. Concurrent with these mitigation measures, monitoring plans have been developed that would be used to gauge the effectiveness over time of each mitigation measure. If prior experience or analysis shows that a given mitigation measure is likely to reduce but is unlikely to eliminate an impact, an assessment was made to characterize the nature and scale of the anticipated residual impact. Thus, each chapter 3 resource section includes discussions of applicable mitigation measures, monitoring plans, and unavoidable adverse impacts.

Overview

Perhaps the most dominant feature of the proposed Resolution Copper Mine is the great size and depth of the ore body; for this reason, Resolution Copper plans to extract the ore from below, using gravity, in a technique known as “block caving” or “panel caving.” However, removal of such a large volume of rock would result in an approximately 1.8-mile-wide and between 800- and 1,115-foot-deep subsidence crater at the Oak Flat Federal Parcel. Along with a discussion of subsidence impacts, this section of the EIS describes known geological characteristics at each of the major facilities of the proposed mine, including alternative tailings storage locations, and how the development of the project may impact existing cave and karst features, paleontological resources, mining claims, and geological hazards.

3.2 Geology, Minerals, and Subsidence

3.2.1 Introduction

This section presents an overview of the geology and mineral resources within the analysis area, analyzes the estimated extent, amount, and timing of potential land subsidence resulting from underground mining activities, and the potential impacts on cave and karst resources, paleontological resources, and mining claims.

Some aspects of the analysis are briefly summarized in this section. Additional details not included are captured in the project record (Newell and Garrett 2018a).

3.2.2 Analysis Methodology, Assumptions, and Uncertain and Unknown Information

3.2.2.1 Analysis Area

The analysis area for geology, minerals, and subsidence considers the potential direct effects of panel cave mining, the associated recovery of economic minerals, the footprint disturbance of all proposed facilities, and the exchange of Federal lands for private lands (“offered lands”). These areas are shown in figure 3.2.2-1.

Indirect effects are those caused by the action and are later in time or farther removed in distance but are still reasonably foreseeable. Potential indirect effects on geology and minerals could be related to the following:

- The area of groundwater dewatering, which could impact hydrogeological and geotechnical properties, as well as result in additional subsidence. Assessment of additional subsidence from groundwater dewatering is discussed in Section 3.7.1, Groundwater Quantity and Groundwater-Dependent Ecosystems.
- The reactivation of geological structures, such as joints and faults directly adjacent to the area of panel caving and subsidence, or in the region. These impacts are assessed in this section.
- Subsidence-related impacts on caves, karst resources, and mine shafts and adits in the analysis area. These impacts are assessed in this section.
- Changes to mineral availability as a result of the proposed land exchange, which in some cases may remove land parcels from mineral entry.

3.2.2.2 Surface Subsidence Review

Note that two different types of subsidence have been raised as concerns for the Resolution Copper Project. This section of the EIS addresses surface subsidence that occurs at the mine site due to the block-cave mining itself. Possible subsidence resulting from groundwater pumping for the mine water supply is addressed in section 3.7.1.

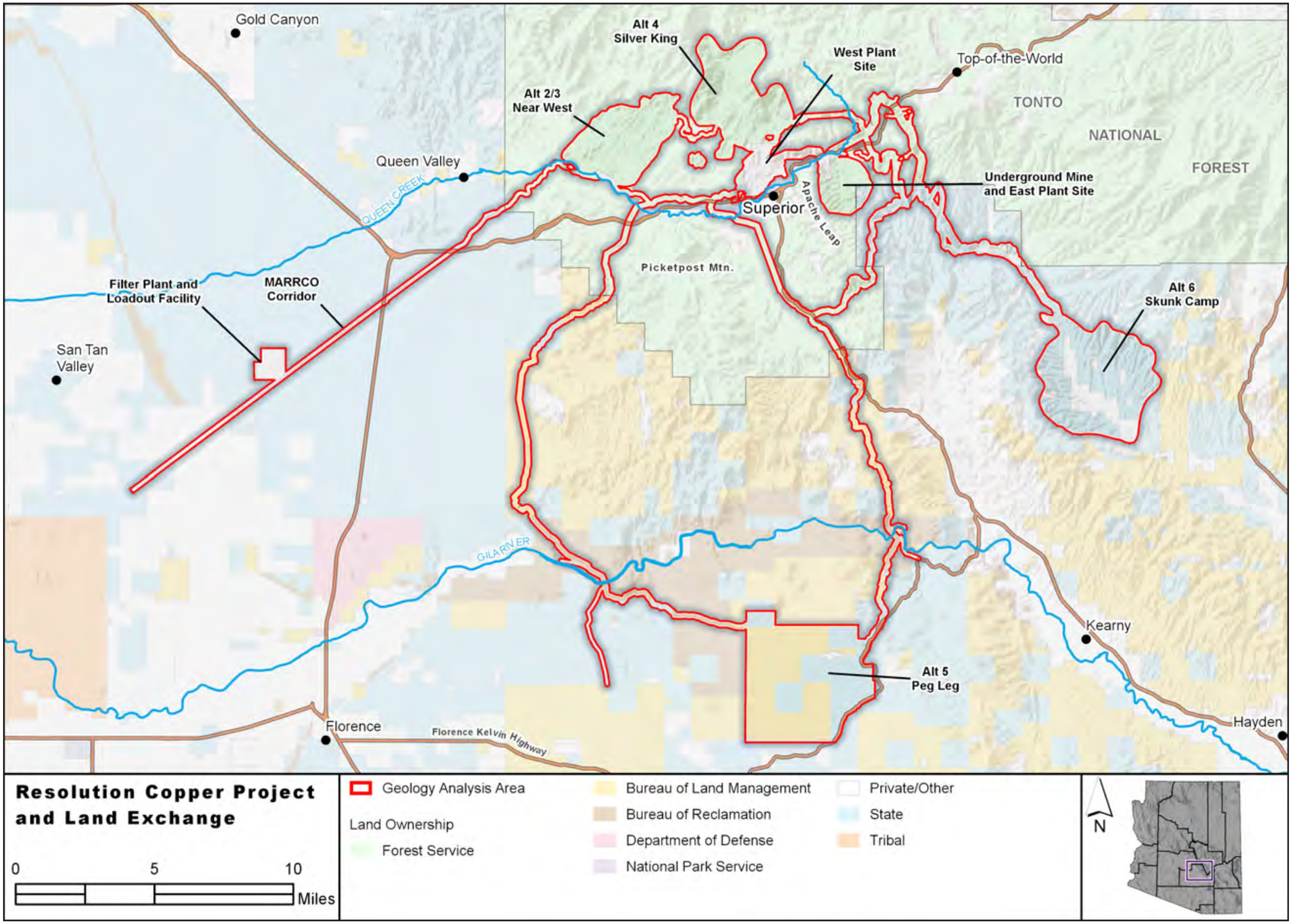


Figure 3.2.2-1. Geology, minerals, and subsidence analysis area

The understanding of regional and local geology relied on U.S. Geological Survey (USGS) maps, geological mapping data provided by Resolution Copper, and mineral resource information from Resolution Copper reports and published resource information. Subsidence effects were originally assessed in the GPO (Resolution Copper 2016d), but Resolution Copper conducted further modeling of the proposed caving operations, estimated the extent and depth of ground surface subsidence, and evaluated the potential impact on Apache Leap, Devil's Canyon, and the serviceability of U.S. 60 (Garza-Cruz and Pierce 2017, 2018).

The Tonto National Forest formed a Geology and Subsidence Workgroup to direct and evaluate this work. In 2017 and 2018, the Geology and Subsidence Workgroup submitted five formal data requests to Resolution Copper and participated in two site visits and seven technical meetings as part of the review. This review is documented in "Resolution Copper Project and Land Exchange Environmental Impact Statement: Geologic Data and Subsidence Modeling Evaluation Report" (BGC Engineering USA Inc. 2018a).

Resolution Copper developed an estimate of surface subsidence based on a three-dimensional numerical model of the proposed panel caving operation using an industry-standard model called FLAC3D (Garza-Cruz and Pierce 2017). The numerical model simulated caving and predicted ground surface subsidence, fracture limits, and cave angle (figure 3.2.2-2). The fracture limit consists of an area around the actual caved area in which the ground surface could be broken with open tension cracks and is the outer limit of any potential large-scale surface cracking (or fracturing). Cave angle is a key factor in estimating the extent of the surface subsidence. The model estimates a subsidence cave angle on the order of 70 to 78 degrees (angle varies with depth), with the cave fractures breaking through to the surface by year 6 of operations.

After reviewing Resolution Copper's geological data and subsidence modeling, the Geology and Subsidence Workgroup concluded the following:

- All aspects of geological data collection, including drilling, sample recovery, core logging, data management, and laboratory testing, met or exceeded industry standards.
- Resolution Copper's interpretations of geological structures, faults, rock properties, geotechnical data, and assumptions are reasonable.
- Geological data outside the mineralized zone, as well as for the Camp and Gant Faults, are not as well represented statistically as in the mineralized zone. To address this, conservative modeling assumptions were used and sensitivity analyses to account for sparse data in these areas.
- Resolution Copper's interpretations of subsidence are reasonable; therefore, the Geology and Subsidence Workgroup did not propose any alternative interpretations. However, there are numerous input variables and several layers of interpretation involved in modeling surface subsidence. There are several areas of uncertainty and some areas of sparse or low confidence data; actual surface subsidence could vary from the modeled results.

There is a great deal of interpretation required throughout the entire process, from data collection to testing and analysis, to model input and interpretations, and sensitivity runs. There are two approaches that consider the certainty of the geological and subsidence models. Both approaches were included in the Geology and Subsidence Workgroup review and are discussed in more detail in BGC Engineering (2018a).

- One approach to address uncertainty is empirical, meaning the model results are compared with what has been observed at other similar mines with similar geological settings. The modeled cave angle was compared observed cave angles from a database of more than 100 cave mining operations throughout the world, including both historical mines that have ceased to operate and those still producing (Woo et al. 2013); the historic database suggests a range from 72 to 84 degrees, which

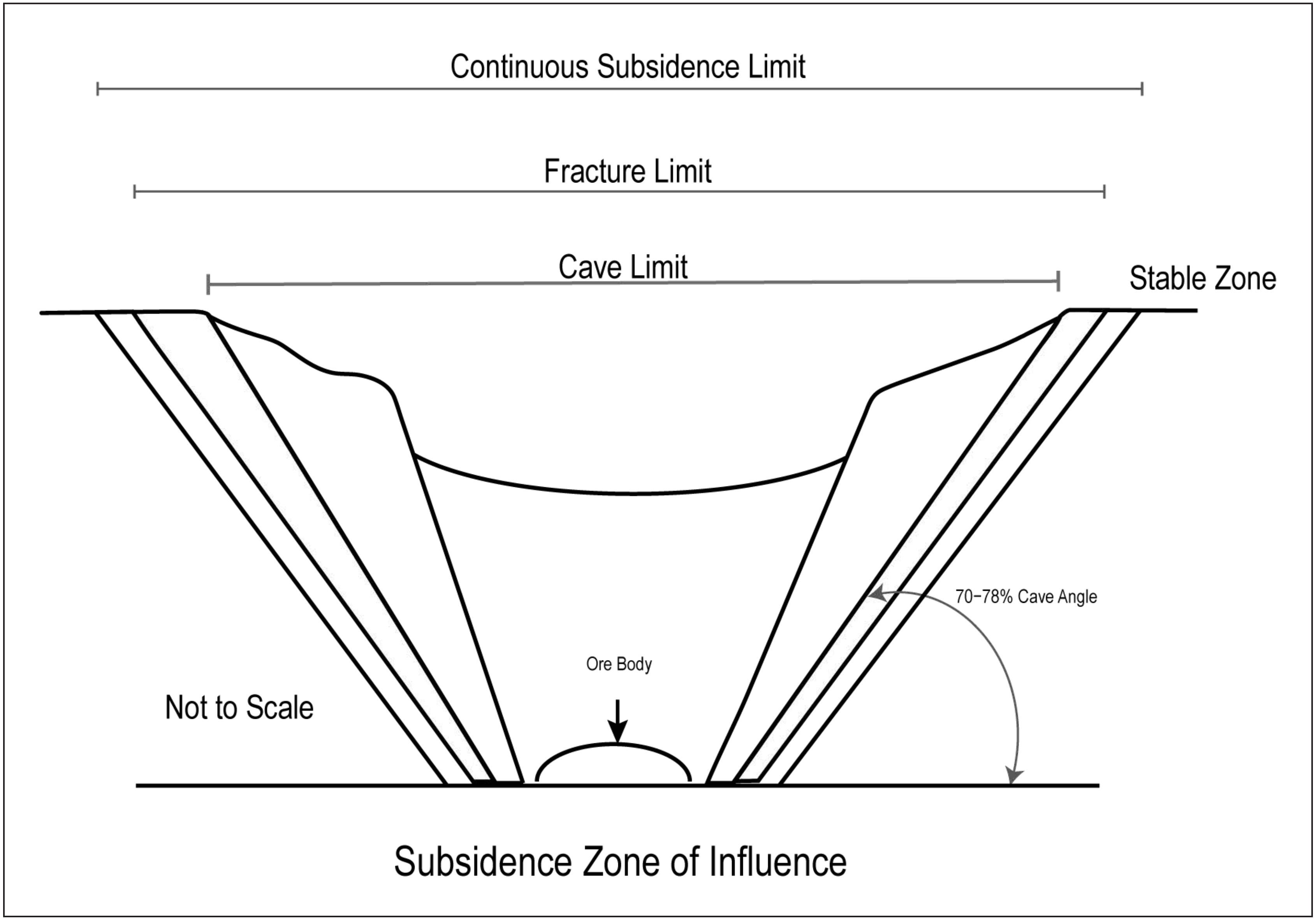


Figure 3.2.2-2. Conceptual cross section of the block-cave and subsidence zone

corresponds well with the modeled results (BGC Engineering USA Inc. 2018a). In a similar way, the conservativeness of the key rock units (Whitetail Conglomerate and Apache Leap Tuff units) was assessed by comparing results to actual measurements collected using underground instruments during the construction of Shaft #10.

- A second approach to address uncertainty is to vary the input parameters to reasonable upper and lower limits to see the resulting cave geometric response (i.e., sensitivity analyses).

3.2.2.3 Geological Hazards

Three types of geological hazards are evaluated: the potential for induced seismicity or reactivation of faults caused by the project; public access to the subsidence area; and the potential for rockfall or other changes to Apache Leap. The potential for induced seismicity is analyzed primarily using analog data observed at other mining sites. The potential for changes to Apache Leap is derived from the subsidence modeling results, and by assessing the changes in stresses and movement caused by the subsidence.

Many of the various rock units and tailings have potential to be acid generating when exposed to oxygen and moisture, resulting in the potential to create water quality problems. This issue is fully evaluated in section 3.7.2 and is not included here as a geological hazard.

3.2.2.4 Paleontological Resources

The probability of finding paleontological resources can be broadly predicted from the geological units present in the analysis area.

3.2.2.5 Caves and Karst Resources

Some cave resources are known to exist in the analysis area, derived from general knowledge of geology and recreation Forest Service specialists. Aside from these known resources, the probability of finding cave resources can be broadly predicted from the geological units present in the analysis area.

Primary Legal Authorities Relevant to the Geology, Minerals, and Subsidence Analysis
• U.S. mining laws, implemented through regulation for administration of locatable minerals (36 CFR 228 Subpart A)
• Paleontological Resources Preservation Act (16 U.S.C. 470aaa through 470aaa-11), implemented through Paleontological Resources Preservation regulations (36 CFR Chapter 2, Part 291)
• Federal Cave Resources Protection Act of 1988 and its implementing regulations at 43 CFR Part 37

3.2.2.6 Unpatented Mining Claims

The known unpatented mining claims associated with the analysis area were taken from comprehensive claims databases administered by the BLM. The focus of this analysis is on claims that are not related to the Resolution Copper Project, but that could be impacted by the project.

3.2.3 Affected Environment

3.2.3.1 Relevant Laws, Regulations, Policies, and Plans

Metals and other mineral resources on NFS lands are managed in accordance with the Mining and Minerals Policy Act of 1970, which states that the Federal Government should “foster and encourage private enterprise in the development of economically sound and

stable industries, and in the orderly and economic development of domestic resources to help assure satisfaction of industrial, security, and environmental needs." Administration of locatable mineral resources on NFS lands follows direction in Federal regulations (36 CFR 228 Subpart A); locatable minerals are those subject to claim and development under the General Mining Law of 1872, as amended.

The Multiple-Use Mining Act of 1955 reaffirms the right to conduct mining activities on public lands, including mine processing facilities and the placement of mining tailings and waste rock. Although a right to conduct mining activities exists, proposals must comply with applicable Federal and State environmental protection laws, and the Forest Service can require reasonable measures, within its authority, to minimize impacts on surface resources (see 30 U.S.C. 612 and 36 CFR 228.1). Mining claim location and demonstration of mineral discovery are not required for approval of locatable minerals operations subject to Forest Service regulations at 36 CFR 228 Subpart A.

One of the alternatives would involve construction of a tailings storage facility on BLM land instead of NFS land. BLM operates under different mining regulations (43 CFR 3809), but also has limited discretion for approving mining operations, provided the mine complies with applicable Federal and State environmental protection laws. As noted in chapter 2, BLM would require the submittal of a separate mining plan of operations to determine whether unnecessary or undue degradation would occur (43 CFR 3809.11(a)) and could require reasonable mitigation measures if determined necessary.

Alternative 6 does not involve any Federal land. Activities and resource impact occurring on these lands would not be regulated under either Forest Service or BLM regulations, though Resolution Copper would potentially employ some of the same environmental protection measures and mitigation.

3.2.3.2 Existing Conditions and Ongoing Trends

Regional Geology – East Salt River Valley, Superior Basin, and Oak Flat

The project is located within a geological region known as the Basin and Range province, near the boundary with another geological region known as the Arizona Transition Zone. The Basin and Range physiographic province is generally characterized by a series of mountain ranges separated by broad valleys filled with geologically young alluvium. The mountain ranges are typically bounded by faults that run northwest-southeast and north-south (Wong et al. 2013). At the northeastern edge of the Basin and Range province is the Arizona Transition Zone, a mountainous region that rises toward the highlands of the Colorado Plateau in northeastern Arizona. The Arizona Transition Zone is geologically complex, but generally consists of belts of linear rugged ridges, separated by relatively narrow valleys.

West of Whitlow Ranch Dam and Gonzales Pass the East Salt River valley begins—a 30- to 40-mile-wide alluvial valley that is typical of the Basin and Range. The Desert Wellfield is located in the East Salt River valley, where groundwater is readily accessible in the extensive, thick, alluvial aquifers. General elevation of this area is about 1,500 feet amsl.

The area roughly east of Whitlow Ranch Dam and east of Apache Leap is called the Superior Basin. This area is where the town of Superior, the West Plant Site, and the Alternative 2 tailings storage facility are located. The Superior Basin is about 10 miles wide, and generally flat, but unlike the East Salt River valley, young alluvium is limited to areas along washes and the main drainage of Queen Creek. Between drainages, low ridges formed of older geological units dominate the Superior Basin. The most distinctive landform immediately in the Superior Basin is

Picketpost Mountain, an isolated butte of Tertiary-aged rock[22] with a peak at 4,378 feet. Queen Creek originates in the Oak Flat Plateau, cuts a deep canyon through the Apache Leap escarpment, and flows west through the town of Superior before continuing southwestward across the Superior Basin. The Superior Basin generally lies about 2,200 to 2,900 feet amsl.

East of Superior lies the rugged Oak Flat Plateau, with an elevation of roughly 4,000 to 4,600 feet amsl. Oak Flat is about 3 miles wide, with the eastern edge formed by Devil's Canyon. On the west, the prominent Apache Leap escarpment forms the division between Oak Flat and the Superior Basin. The East Plant Site is located on Oak Flat, and the Resolution ore deposit is located below Oak Flat.

Regional Geological Units

Previous researchers and Resolution Copper have mapped the geology of the analysis area. The most recent detailed geological map is a compilation of published USGS mapping and Resolution Copper geological mapping (Hart 2016). A number of other useful sources also exist, including the GPO (Resolution Copper 2016d; Spencer et al. 1996). A summary of the main geological units from oldest to youngest is presented in this section, and these are intended to be used in conjunction with the tables and figures reproduced in Newell and Garrett (2018a).

Regional geology of the Superior Basin and Oak Flat is shown in figure 3.2.3-1 and shown as a conceptual cross section in figure 3.2.3-2. The abbreviations of the most common mapping units are included in the following text, which are commonly used on geological maps.

PRECAMBRIAN UNITS

The oldest rock units in the analysis area are more than 1 billion years old and include the Pinal Schist (pCpi); the Apache Group (pCy), which includes sedimentary and metamorphic units like shale, quartzite, limestone, and basalt; and the Troy Quartzite. Intrusions of granite, granodiorite, diorite, and diabase are found throughout these sedimentary units. These rocks underlie the entire analysis area but are only exposed in the western part of the Superior Basin.

PALEOZOIC SEDIMENTARY UNITS

Overlying the Precambrian units are sequences of Paleozoic-age (Pz) sedimentary formations. From oldest to youngest these include the Bolsa Quartzite, the Martin Formation, the Escabrosa Limestone, and the Naco Limestone. These units are well-exposed in the hills rising toward the Apache Leap escarpment.

CRETACEOUS-TERTIARY VOLCANIC UNITS

Numerous types of volcanic intrusions, including sills, dikes, and stocks of granite and diorite are located throughout the area. One well-known unit is the Silver King quartz diorite north of the town of Superior. A particularly thick sequence of Cretaceous-age volcanoclastic rock (Kvs) has been observed within the Resolution Graben (the Graben is

22. The use of technical geological terms has been intentionally limited in the EIS. However, the relative age of geological units can be important to understanding impacts, as some geologic time periods are commonly used to describe units. The following ages are the most commonly used, in order from youngest to oldest. The term "consolidated" means the unit is hard rock, whereas unconsolidated units are still loose, like soil or sand:

Quaternary – Refers to geologically young, largely unconsolidated units, that are less than 2.6 million years old.

Tertiary – Refers to geological units, largely consolidated, that are between 66 and 2.6 million years old.

Cretaceous – Refers to consolidated geological units that are about 145 to 66 million years old.

Paleozoic – Refers to consolidated geological units that are about 541 to 252 million years old.

Precambrian – Refers to the oldest geological units in the analysis area, older than 541 million years.

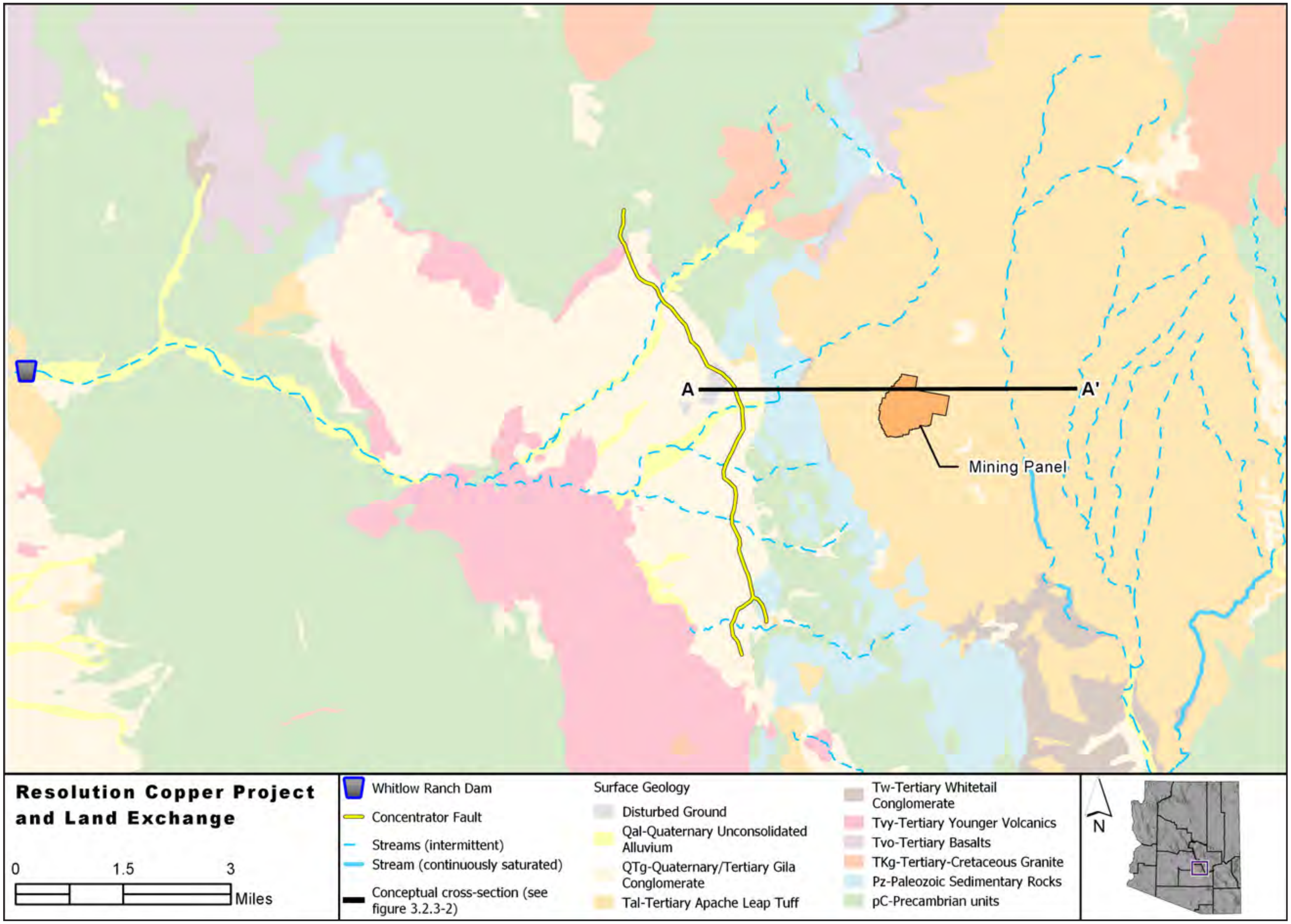


Figure 3.2.3-1. Generalized geological map of Superior Basin and Oak Flat

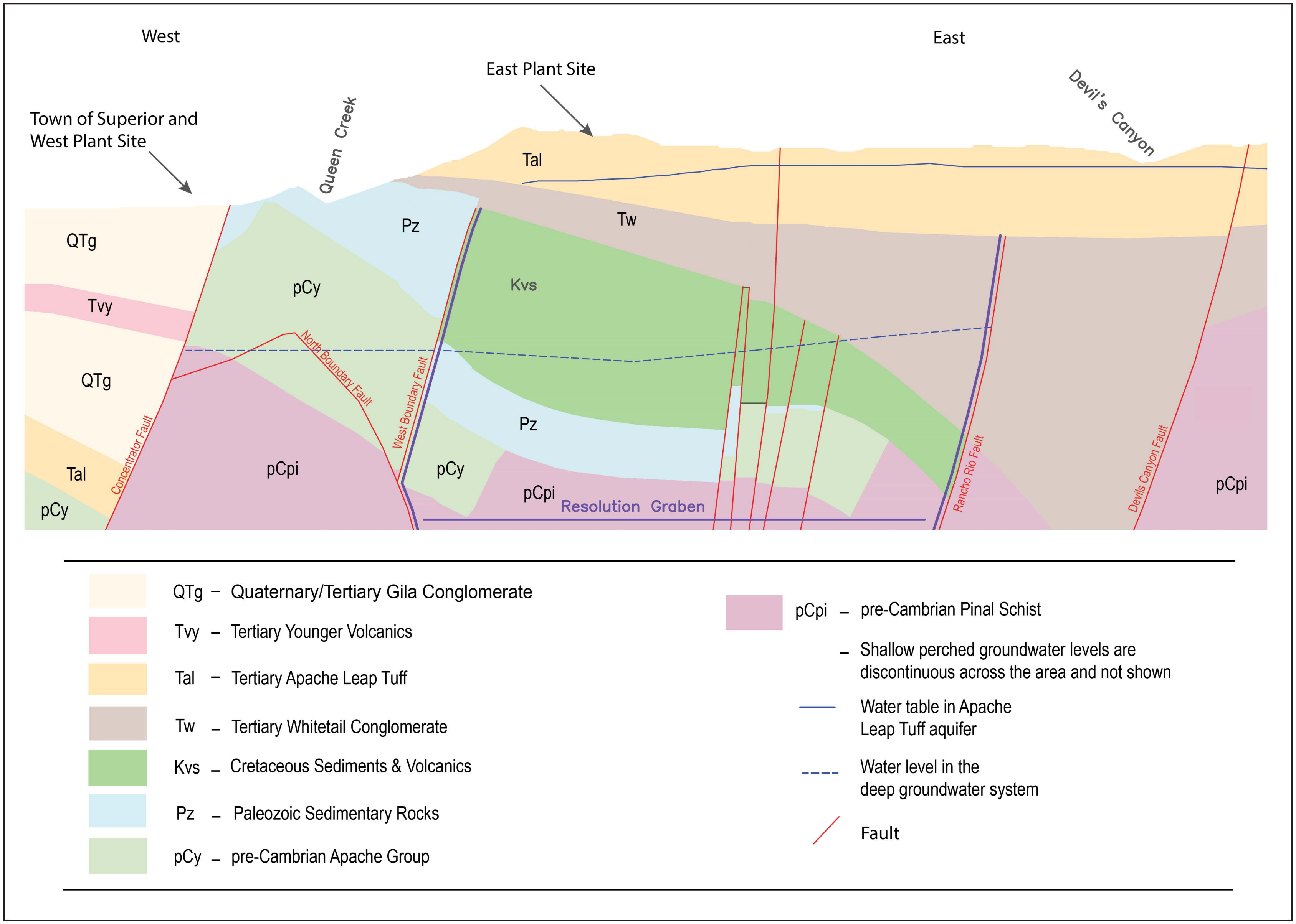


Figure 3.2.3-2. Generalized geological cross section

described in more detail later in this section), but these units are not known to outcrop anywhere in the analysis area (Kloppenburg 2017).

TERTIARY VOLCANOCLASTIC UNITS

Two units of key importance to both the analysis of subsidence and the analysis of impacts from groundwater drawdown are the Tertiary-aged Whitetail Conglomerate (Tw) and the Apache Leap Tuff (Tal). The older and deeper of these two geological units is the Whitetail Conglomerate, which consists of non-volcanic conglomerate and sandstone, as well as sedimentary breccia and mudstone. Overlying the Whitetail Conglomerate is the Apache Leap Tuff. The Apache Leap Tuff is a welded tuff of volcanic ash. It caps the Oak Flat plateau and forms the escarpment of Apache Leap. The Apache Leap Tuff also forms the most important aquifer unit in the area, supporting the perennial flow in springs and in Devil's Canyon. The Whitetail Conglomerate is important hydrologically because it largely isolates groundwater in the Apache Leap Tuff from dewatering taking place in the deep groundwater system (see section 3.7.1).

GILA CONGLOMERATE

The Gila Conglomerate (Qtg) is widespread throughout the Superior Basin and elsewhere in Arizona, including at the Skunk Camp location. The Gila Conglomerate consists of coarse gravel, cobbles, and boulders, many of which are derived from the Tertiary volcanics. The formation outcrops predominantly on the west side of the Concentrator Fault in the Superior Basin, is over 3,000 feet thick in places, and forms much of the surface geology near the Alternative 2 and Alternative 3 tailings storage facility. The Gila Conglomerate has portions that are unconsolidated or only weakly consolidated, as well as consolidated areas. The Gila Conglomerate is generally Tertiary aged but has also been mapped along with Quaternary deposits. For the purposes of the mapping presented in this section, it is presented as both Quaternary and Tertiary deposits.

QUATERNARY ALLUVIAL DEPOSITS

Quaternary deposits (Qal) consist of recent and near-recent stream deposits in basins, fans, terraces, floodplains, and channel deposits, as well as landslide and colluvial deposits. Particles range in size from clay, silt, and sand, to gravels, cobbles, and boulders. These deposits are generally unconsolidated but may be weakly to strongly cemented by calcite (i.e., caliche deposits). These deposits underlie most streams in the area, forming shallow, alluvial aquifers that store and transmit groundwater, and in places support riparian vegetation and perennial flow (see section 3.7.1).

Structural Geology and Faults

Many of the faults of importance to the structural geology in the analysis area are typical of Basin and Range faults. These are north- to northwest-trending normal faults with downward movement to the west, with movement dating from Tertiary or Quaternary time (Hehnke et al. 2012). The Superior Basin is bounded by the Concentrator Fault to the east and by the Elephant Butte Fault to the west. The Concentrator Fault is historically important as it displaces the Magma ore vein to an unknown depth and therefore defined the western limit of production in the Magma Mine. The Elephant Butte Fault is a major west-side-down normal fault that is located along the west side of Gonzales Pass and crosses Queen Creek east of Queen Valley near Whitlow Ranch Dam (Ferguson and Skotnicki 1996).

The Resolution ore deposit, lying about 4,500 to 7,000 feet below Oak Flat, is located in a structural feature called the "Resolution Graben." A graben is an area that is bounded on the sides by normal faults and is downthrust below those faults. The Resolution Graben is bounded by the West Boundary, North Boundary, South Boundary, Conley Springs, and Rancho Rio Faults. The Resolution Graben is hydrologically important because these faults tend to impede groundwater flow (WSP USA 2019). As such, much of the lowering of groundwater levels due to the dewatering that has taken place in the deep groundwater system since 2009 has been limited to the Resolution Graben (see section 3.7.1).

The analysis area has undergone multiple episodes of folding and faulting dating to the Precambrian. During the Tertiary period, two separate widespread orogenic (or mountain-building) events contributed to the structural geology of the analysis area, as well as the entire Southwest (the Late Sevier-Early Laramide Orogeny, and the Basin and Range extension) (Kloppenburg 2017). Regional extension, normal faulting, and tilting ended after Tertiary volcanism and during the deposition of Gila Conglomerate and Sandstone (Tcg) (Spencer and Richard 1995). The rotation, thickness, and offset of the geological units in the area (see figure 3.2.3-2) are the result of this series of large-scale structural movements.

Mineral Resources

GENERAL MINERAL OCCURRENCE

Mineral occurrences in the analysis area include a range of metallic, non-metallic, and industrial minerals. There is a more than 100-year history of silver and copper mining near the analysis area, and several operations continue to contribute to the region's economy. In addition to the nearby formerly producing Magma and Silver King mines, over 30 (active or inactive) mines are regionally located near what is known as the "Copper Triangle." These represent a variety of operations but primarily include copper, gypsum, and marble mining. The closest currently active major copper mines are the Ray Mine, approximately 9 miles south of the analysis area, the Pinto Valley Mine, approximately 14 miles northeast of the analysis area, and the Carlota Mine, also northeast of the analysis area. These mines are open-pit operations, but, like the Resolution ore deposit, they are large tonnage, low-grade copper porphyry deposits (Kloppenburg 2017).

RESOLUTION ORE DEPOSIT

The Resolution ore deposit is approximately 64 million years old and is a porphyry copper-molybdenum deposit. It lies approximately 4,500 to 7,000 feet below Oak Flat. As defined by the 1 percent copper shell, the deposit extends over an area of at least 1.2 miles in an east-northeast direction, and 0.9 mile in a north-northwest direction. A detailed description of the deposit and associated mineralization is included in Hehnke et al. (2012).

Rock types with diabase, limestone, and local breccia host and control the strongest copper mineralization. Quartz-rich sedimentary rocks and Cretaceous-Tertiary intrusive rocks demonstrate the strongest molybdenum mineralization. The highest copper grades (greater than 3 percent) are located in the upper central portion of the deposit associated with a large hydrothermal breccia body and hosted primarily in breccia and diabase. The total mineral resource at the Resolution ore deposit is currently estimated (indicated and inferred) to be 1,970 million tons (1,787 million metric tonnes), with an average grade of 1.54 percent copper and 0.035 percent molybdenum (Rio Tinto 2018).

The location and geometry of the mineralization are structurally controlled by several generations of faulting that occurred before, during, and after mineralization. Chalcopyrite is the dominant copper mineral in the deposit, with lesser chalcocite and bornite. Molybdenum occurs primarily as molybdenite. The deposit is associated with hydrothermal alteration and includes a strong pyrite "halo" in the upper areas of the deposit, containing up to 14 percent pyrite. This mineralization has ramifications for water quality, as all of these are sulfide-bearing minerals and have the potential to interact with oxygen and cause water quality problems (acid rock drainage), as discussed in detail in section 3.7.2.

Tailings Storage Facility for Alternatives 2 and 3 – Near West

GENERAL GEOLOGY

The proposed tailings storage facility site for Alternatives 2 and 3, known as the Near West site, is located approximately 3 miles west of the town of Superior and 3 miles east of the community of Queen Valley, between Roblas Canyon on the west and Potts Canyon on the east. A number of geological units underlie the tailings storage facility footprint. Quaternary alluvial deposits are found along the washes, separated by a

series of parallel ridges formed of older rocks. The majority of the area is underlain by Gila Conglomerate, with older Pinal Schist under the southwestern portion of the proposed tailings embankment, and smaller areas of Apache Group, Paleozoic sedimentary rocks, Apache Leap Tuff, and other volcanics (Spencer and Richard 1995).

FOUNDATION CONSIDERATIONS

The Near West location is unique out of the alternative tailings locations in that Resolution Copper has completed geotechnical investigations at the site (Golder Associates Inc. 2017; Klohn Crippen Berger Ltd. 2017). Findings from site investigations (Klohn Crippen Berger Ltd. 2017) and other studies (Klohn Crippen Berger Ltd. 2018a, 2018b) at the Near West site include the following foundation considerations, which would need to be factored into the design:

- Some units exhibit weak foundation conditions. These include zones with weak clay layers, zones of potentially collapsible soils (including in the Gila Conglomerate), and weakness parallel to foliation (in the Pinal Schist). These conditions potentially could affect embankment stability.
- Dissolution features, such as voids and open joints, are present in the Mescal Limestone (part of the Apache Group), particularly near the contact between the limestone and an intruded diabase. Resolution Copper has noted open joints in numerous units, including the Gila Conglomerate, and a single high-angle fault with approximately 6 feet of normal displacement was also observed in the Gila Conglomerate. Heavy fracturing was observed in the Pinal Schist. These conditions potentially could affect embankment stability or seepage movement and capture.
- An abandoned mine, Bomboy Mine, is within the southwest corner of the tailings storage facility.

Tailings Storage Facility for Alternative 4 – Silver King

GENERAL GEOLOGY

The Alternative 4 – Silver King tailings storage facility site is approximately 2 miles from the West Plant Site and would occupy the lower end of Silver King Canyon, the lower portion of Whitford Canyon, and Peachville Wash. The Silver King site is approximately 5 miles northeast the Alternative 2 tailings site and shares similar foundation geology. The majority of the geology underlying the tailings facility footprint is Precambrian Pinal Schist, but numerous other geological units are present, including Apache Group units, Bolsa Quartzite, and Tertiary volcanic rocks. Unconsolidated Quaternary alluvial deposits are limited to ephemeral drainages.

Historical mining and exploration have taken place within or near the Silver King site, though the tailings storage facility footprint has been designed to avoid existing mining operations at the Silver King Mine itself (Klohn Crippen Berger Ltd. 2018c), which is 0.7 mile east of the site. The Silver King Mine workings are not expected to extend within the footprint of the tailings storage facility. Silverona Mine, Fortuna Mine, Black Eagle Mine, and “Unnamed Mine” are located near or in Peachville Wash. Also, the McGinnel Claim is at the intersection of the Main and Concentrator Faults, approximately 0.5 mile north of Silver King Wash, and within the footprint of the tailings facility.

FOUNDATION CONSIDERATIONS

No site-specific geotechnical investigations have been performed at the Silver King site. In general, many of the site characteristics at Silver King are anticipated to be similar to the Near West site, where geological units are the same. The following foundation considerations have been noted that would need to be factored into the design:

- One major difference noted by Klohn Crippen Berger (2018c) is the presence of potentially liquefiable (e.g., loose granular deposits that are saturated or will become saturated) soils in the Quaternary alluvium and in landslide deposits associated with

weak foliation in Pinal Schist. These conditions potentially could affect embankment stability.

- Abandoned mine workings within the tailings storage facility footprint could collapse beneath the tailings piles (Klohn Crippen Berger Ltd. 2018c), but none are known specifically to exist at this time.

Tailings Storage Facility for Alternative 5 – Peg Leg

GENERAL GEOLOGY

Most of the project facilities are located within the East Salt River valley (filter plant and loadout facility, Desert Wellfield), the Superior Basin (West Plant Site, tailings storage facilities under Alternatives 2, 3, and 4), and Oak Flat (East Plant Site). However, two of the alternative tailings storage facilities are located at some distance from the Superior Basin: Alternative 5 (Peg Leg) and Alternative 6 (Skunk Camp).

The Alternative 5 tailings storage facility (also known as the Peg Leg location), is located approximately 15 miles south of the West Plant Site and south of the Gila River, in a flat, northwest- to southeast-trending valley with Donnelly Wash (a tributary to the Gila River) as its main drainage (figure 3.2.3-3). This drainage lies at the eastern edge of the Basin and Range province and is typical of that geology. Alternative 5 is primarily underlain by a flat valley of Quaternary alluvial material, bounded by sedimentary and granitic rocks, although these hard rock areas do not rise to a great height and instead form a series of low hills at the margins of the valley.

The PAG tailings for Alternative 5 would be located to the east side of the facility and would be underlain by granitic rocks that include Precambrian Ruin Granite and Tertiary Tea Cup Granodiorite. The NPAG tailings would be located on alluvial deposits, including some travertine near the western boundary of the project site (Golder Associates Inc. 2018a).

FOUNDATION CONSIDERATIONS

Current foundation characterization for the Peg Leg site is based on surficial geology mapping, site reconnaissance, geophysical surveys (electrical resistivity, refraction seismic surveys, and gravity surveys), local well logs, and regional literature (Fleming, Kikuchi, et al. 2018; Golder Associates Inc. 2018a; hydroGEOPHYSICS Inc. 2017). The following foundation considerations have been noted that would need to be factored into the design:

- Fracture zones have been mapped on the bedrock surface near the Peg Leg tailings storage facility site, but there are no known active seismic features in the vicinity, and seismicity is expected to be similar to the Near West location.
- The Precambrian Ruin Granite and Tertiary Tea Cup Granodiorite are expected to have low permeability and high strength. However, well logs in the tailings storage facility area reviewed by Golder Associates (2018a) indicate that the granitic bedrock may be highly decomposed and weathered in areas, even to significant depths, which could indicate higher permeability and lower strength in these areas. These conditions potentially could affect embankment stability or seepage movement and capture.
- The presence of travertine may indicate shallow perched groundwater zones exist. These conditions potentially could affect embankment stability or seepage movement and capture.

Tailings Storage Facility for Alternative 6 – Skunk Camp

GENERAL GEOLOGY

Alternative 6 (also known as the Skunk Camp location) is located in a narrow northwest- to southeast-trending valley with Dripping Spring Wash (a tributary to the Gila River) as its main drainage. The Quaternary alluvium within the valley is bounded to the southwest by the Dripping

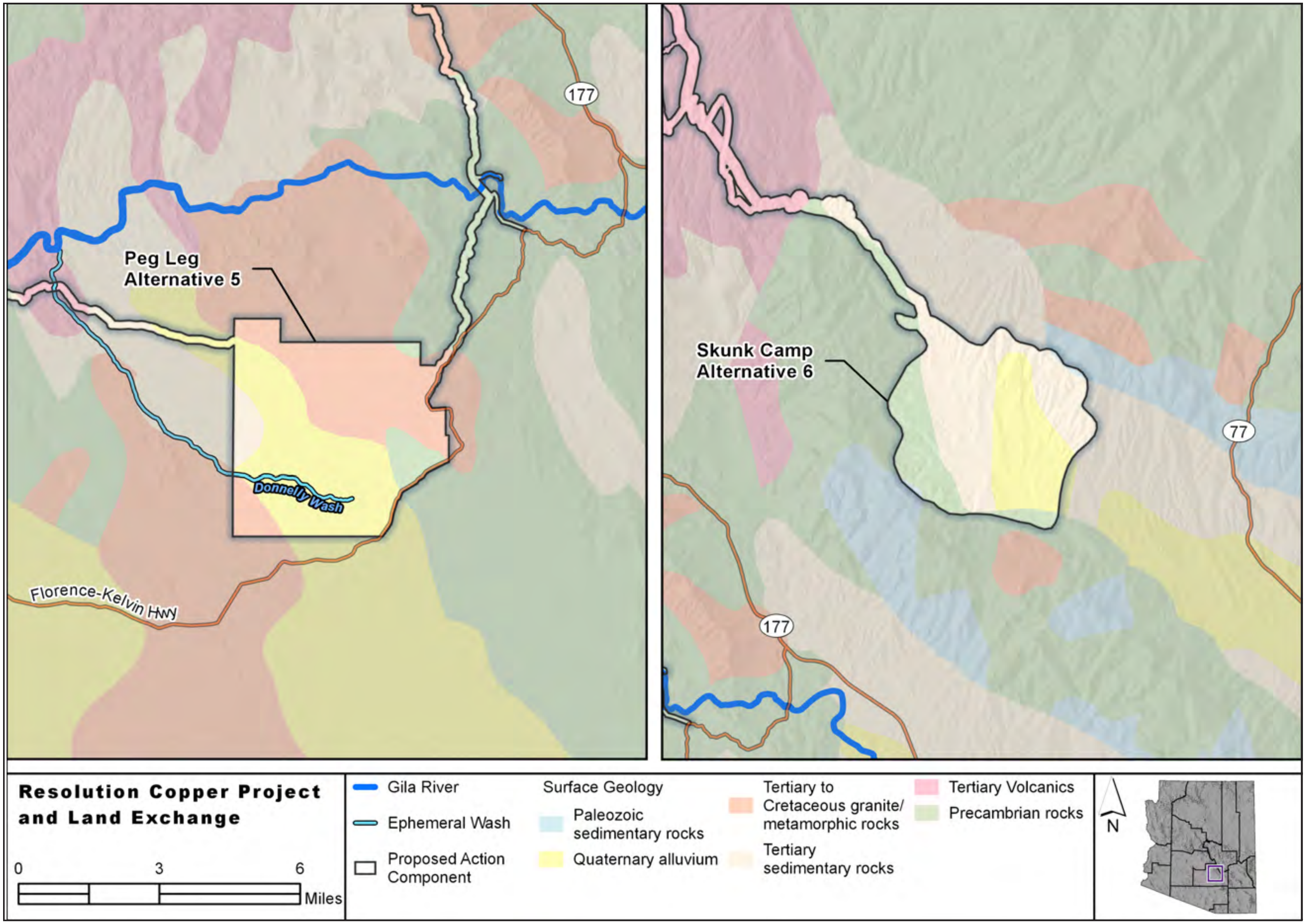


Figure 3.2.3-3. Generalized geological map of Peg Leg and Skunk Camp locations

Spring Mountains, and to the northeast by the Pinal and Mescal Mountains.

Underlying geological units are similar to Alternatives 2, 3, and 4, primarily Precambrian units such as Pinal Schist, overlain by Apache Group units, and Troy Quartzite (see figure 3.2.3-3). The valley itself is infilled with Gila Conglomerate, estimated to be over 1,500 feet thick in some locations. Quaternary alluvium partially covers the conglomerate and is present along the valley bottom and drainages. Occasional travertine deposits have been observed in valley walls.

FOUNDATION CONSIDERATIONS

Foundation characterization is based on recent site reconnaissance visits, limited well logs, regional geological maps, and assumptions based on similar sites given the similar geology (i.e., Near West) (Fleming, Shelley, et al. 2018; Klohn Crippen Berger Ltd. 2018e). The following foundation considerations have been noted that would need to be factored into the design:

- Potential strength reduction could result in areas due to saturation of the Gila Conglomerate. These conditions potentially could affect embankment stability.
- Gila Conglomerate varies across the site, and has been noted to be less cemented and coarser grained than at the Near West site, especially on the north end of the site; this unit may therefore exhibit higher permeability at the Skunk Camp site, compared with the Near West site, which could impact seepage within the basin. These conditions potentially could affect embankment stability or seepage movement and capture.
- Potential for groundwater flow paths—it is not known whether the faults on-site act as preferential flow paths or low-permeability boundaries for groundwater flows at this time.
- The presence of travertine may indicate shallow perched groundwater zones exist. These conditions potentially could affect embankment stability or seepage movement and capture.

Geological Hazards

SEISMICITY

Regional Seismicity

Historical natural seismicity is low within this general region. Within approximately 30 miles of the proposed mine site there have been three historical earthquakes with a magnitude greater than 3: a magnitude 4.2 in 1963; a magnitude 4.4 in 1969; and a magnitude 3.1 in 2010 (U.S. Geological Survey 2018c).

Lettis Consultants International completed site-specific hazard analyses for the proposed Near West tailings storage facility (Wong et al. 2017) and the mine site (Wong et al. 2018). A historical catalog was compiled including earthquakes within a 124-mile radius of the mine, and includes 26 events of moment magnitude 5 to 5.9, three events of magnitude 6 to 6.9, and three events of magnitude 7 and greater. However, one of the magnitude 7 events, dated 1830 in the record, is considered poorly documented and suspect (DuBois et al. 1982).

The largest earthquake in the record is a magnitude 7.4 earthquake that occurred in 1887 in northern Sonora, Mexico, approximately 200 miles southeast of the site (DuBois et al. 1982; Suter and Contreras 2002). Ground shaking was felt throughout Arizona and as far north as Albuquerque, New Mexico, and would also have been felt in the

analysis area. The maximum felt intensity was measured as between Modified Mercalli (MM) intensity XI and XII, and MM VI would have been observed at the mine site (DuBois et al. 1982).[23]

The closest significant earthquake to the mine was a magnitude 5.0 event that occurred in 1922 near Miami, Arizona, approximately 13 miles east-northeast of the site (DuBois et al. 1982). The event was felt in the town of Miami, but no structural damage was reported (DuBois et al. 1982). Lettis Consultants International (Wong et al. 2018) surmised that the felt intensity likely would have been MM IV. This event was recorded on a seismograph over 80 miles away in Tucson; therefore, the location and size of the event are highly uncertain (Wong et al. 2008).

More recently, in 2014, there was a magnitude 5.3 event near the town of Duncan, Arizona, close to the Arizona–New Mexico border, and approximately 120 miles east-southeast of the mine site. This event was widely felt in Arizona and western New Mexico, with a reported intensity of MM V near the epicenter. Based on reported intensities surrounding the site, an intensity between MM II and III would have been observed at the mine (Wong et al. 2018). Following this event, there were over 40 likely aftershocks ranging from magnitude 2.0 to 4.0.

It should be noted that regional seismic hazard is a consideration handled explicitly during the design of tailings storage facilities, beyond the brief narrative provided here (see section 3.10.1).

Induced Seismicity

Seismic events due to human activity can and do occur, and are commonly referred to as “induced seismicity” (National Academy of Sciences 2013). There are two types of mine-induced seismicity (Gibowicz and Kijko 1994; Richardson and Jordan 2002). Type A events are smaller in magnitude (less than 1), related directly to mining activities (i.e., digging, blasting), and occur at or near the active mining face. Type B events have larger magnitudes and are the result of shear failure along a pre-existing structure (i.e., fault, joint bedding plane, or other zones of weakness). They may occur on structures not exposed at the active mine face, but which are affected by the perturbed stress field.

Induced seismicity has been recognized and observed in mines around the world, although not all mines exhibit seismicity (Gibowicz and Kijko 1994); over 100 years of worldwide observations of induced mine seismicity show that induced events of greater than magnitude 5 are rare, whereas events of magnitude 3 or less are more common. Since 2013, seismic activity has been has been observed in two mines in Arizona: in southeastern Arizona near Morenci (up to magnitude 3.1), over 120 miles east of the analysis area, and in northeastern Arizona, south of Shonto (up to magnitude 2.9) (U.S. Geological Survey 2018b), approximately 300 miles north of the analysis area. These minor magnitudes are within the range of seismicity currently observed in the region. However, these events consist of mine explosions, not earthquakes induced by mining. The closest occurrences of

23. The Modified Mercalli scale is a method of measuring the intensity of an earthquake at a given location, and is based on the real-world effects people would experience and observe. The intensities described above are generally described as follows:

    VI – Generally noted as being felt by all, and strong enough to frighten many; strong enough to move some heavy furniture; and slight damage like falling plaster.

    V – Generally noted as being moderate. It is felt by nearly everyone, and many are awakened. Some dishes and windows are broken, and unstable objects overturned. Pendulum clocks may stop.

    IV – Generally noted as being relatively light. It typically can be felt indoors by many but outdoors by only a few people; at night, some people are awakened; dishes, windows, and doors are disturbed, and walls make cracking sounds; and standing vehicles will rock noticeably.

    III – Weak. Many people do not recognize it as an earthquake, standing vehicles may rock slightly, and vibrations are similar to the passing of a truck.

    II – Weak. Felt only by a few persons.

mining-induced seismicity are in the coal mines of the Wasatch Plateau in eastern Utah and western Colorado (Wong 1993).

The nearest mapped Quaternary “active” surface fault relative to the mine is the Sugarloaf fault zone, located about 35 miles to the northwest (U.S. Geological Survey 2018a) of the mine, and 30 miles southeast of the proposed Near West tailings storage facility site (Wong et al. 2017). The Sugarloaf fault zone runs along the western margin of the Mazatzal Mountains (Pearthree et al. 1995). The fault likely experienced little Quaternary movement, as indicated by the minimal relief across the fault (Pearthree 1998); trenching to examine sediments shows that the fault disturbed deposits older than 12,000 years, but did not disturb younger deposits (Pearthree et al. 1995).

Faults are located within the footprints of several of the alternative tailings storage facilities. The Concentrator, Main, and Conley Springs Faults cross the Silver King site, but previous research indicates that these faults are healed (Cross and Blainer-Fleming 2012), and are not believed to be active within the last 2.6 million years (Wong et al. 2017). The Skunk Camp site includes two mapped faults, the Dripping Springs and Ransome Faults, neither of which are believed to have been active during the past 12,000 years (Wong et al. 2017).

As noted, numerous faults are also located near Oak Flat, bounding the Resolution Graben. These faults are key to how the subsidence area would develop and were incorporated into the subsidence modeling.

LANDSLIDES AND ROCKFALL

Landslides, in the form of general “earth slides,” have been mapped in several locations near the analysis area (Arizona Geological Survey 2018). These include (1) immediately north of U.S. 60, approximately 0.5 mile northeast of the town of Superior, (2) less than 1.0 mile southwest of the mine, and another approximately 2.0 miles south of the mine, and (3) immediately adjacent to and within the northwestern footprint area of the Silver King alternative tailings storage facility site.

Public concern has been raised about the stability of Apache Leap itself, in light of the subsidence that would occur on Oak Flat. The height and steepness of the Apache Leap escarpment speaks to the strength of the Apache Leap Tuff and its overall stability. Observations related to Resolution Copper’s ongoing exploration work confirm the stability of the Apache Leap Tuff, including the strength of the rock observed as Shaft #10 was sunk (Tshisens 2018b).

The stability of Apache Leap is also demonstrated by actual monitoring of the Apache Leap escarpment using LiDAR techniques, which has taken place since 2011 and is still ongoing. This monitoring uses 11 measurement stations and has an accuracy to 0.2 feet. No significant movement has been observed since monitoring began; all movements are attributable to vegetation changes or to small rockfalls (Maptek Pty Ltd. 2011, 2012, 2014a, 2014b, 2015, 2016, 2017).

ABANDONED MINES

Abandoned mine workings or adits pose a safety hazard if they are not properly sealed from public access, and are also a concern with respect to stability of foundations for tailings embankments built in historical mining areas.

Historic-era mining features have been noted on several of the offered land parcels, most notably the Apache Leap South End Parcel on the west side of Oak Flat. Here there are multiple historical mining features and remnants of old mining-related roads located throughout the parcel, including small open cuts, shafts, tunnels, raises, crosscuts, and more extensive underground workings. The major underground mines in this area were principally known as the Grand Pacific and Belmont mines. Entrances to these mines are found on portions of the parcels and appear to date to the early 1900s. The Dripping Springs parcel has also been noted for historic mine activity.

The historic Bomboy Mine was identified in the vicinity of the embankment of the tailing site, in Roblas Canyon. This was an underground copper mine started in 1916, with last production noted in 1971.

Paleontological Resources

Paleontological resources are the fossilized remnants of life. The majority of rock types in the analysis area are igneous (volcanic and plutonic), volcaniclastics, metamorphic rocks, and coarse clastic sedimentary rocks, which are either environments that never had biological activity or were environments that were not conducive to the preservation of fossils or evidence of biological activity. The only formations with potential for paleontological resources are the sequence of Paleozoic sedimentary rocks, namely the Naco Limestone, the Escabrosa Limestone, and the Martin Limestone. These rocks outcrop in the Apache Leap escarpment below the Apache Leap Tuff and extend down to the western edge of the town of Superior.

The following are descriptions of the potential fossil-bearing formations and the fossils typically associated within those formations:

Naco Limestone. The Naco Limestone is roughly 300 million years old, and is a medium- to thin-bedded, gray, white, pale blue to pink limestone (Resolution Copper 2016d). Shallow-shelf marine fossils are common and locally abundant in Naco Limestone and they include foraminifera (especially fusulinids), brachiopods, mollusks (gastropods, clams and other bivalves, cephalopods), tabulate and rugose corals, sponges, bryozoans, echinoderms (crinoids), and rarely, vertebrates like shark teeth and fish bones (Reid 1966; Resolution Copper 2016d).

Escabrosa Limestone. The Escabrosa Limestone is roughly 350 million years old and is equivalent to the Redwall Limestone prevalent in the Grand Canyon. It is a thick-bedded, cliff-forming, resistant, white to dark gray limestone (Blainer-Fleming et al. 2013; Resolution Copper 2016d). This formation potentially contains mostly crinoids and rugose corals with some brachiopods and trilobites. However, it is sparsely fossiliferous and preservation of these fossils is generally poor because they are worn, fragmented, and nearly inseparable from the host limestone.

Martin Limestone. The Martin Limestone is roughly 400 million years old and contains dark to light gray limestone and shale (Pye 1959; Resolution Copper 2016d). This formation can be fossiliferous and potentially contains brachiopods, crinoids, and corals (Blainer-Fleming et al. 2013).

Cave Resources and Karst Landforms

In addition to their preservation of fossils, limestone units also have the potential for cave formation by dissolution of the carbonate rock by groundwater. Of the three Paleozoic limestone formations discussed in the previous section, the Naco and the Escabrosa have the greatest potential for cave formation. According to Huddle and Dobrovolny (1952), the Escabrosa Limestone formation contains karst features that are infilled with rubble breccia and Naco Limestone, indicating extensive karst topography in Central Arizona more than 300 million years ago. The Kartchner Caverns of the Whetstone Mountains of southern Arizona (near Benson), for example, are formed in the Escabrosa Limestone. There are no caves currently mapped in the Paleozoic limestone units within the analysis area and, due to the extensive intrusions and veins, cave formation is likely limited to small, discontinuous cavities.

While several karst features have been noted in Queen Creek Canyon upstream of Superior, only one existing cave has been identified in the area: Hawks Claw Cave is located near Alternative 2 tailings site.

Unpatented Mining Claims

Numerous unpatented mining claims—both lode and placer—are located within the footprint of the mine components. These are summarized in the GPO in appendix A and figure 3.2-1 (Resolution Copper 2016d) for Alternatives 2 and 3, and have been compiled separately for Alternatives 4, 5, and 6 (Garrett 2019a).

- No unpatented claims unrelated to Resolution Copper are located within the Oak Flat Federal Parcel, or on the East Plant Site.

- The West Plant Site is privately owned. No unpatented claims unrelated to Resolution Copper are located around the periphery of the West Plant Site.
- The MARRCO corridor right-of-way is already existing and in use. No unpatented claims unrelated to Resolution Copper are located within the MARRCO corridor.
- Unpatented claims unrelated to Resolution Copper are located within the various alternatives tailings storage facility footprints and/or the tailings pipeline corridor footprints. In Section 3.2.4, impacts on these claims are assessed specific to each alternative.

3.2.4 Environmental Consequences of Implementation of the Proposed Mine Plan and Alternatives

3.2.4.1 Alternative 1 – No Action Alternative

Under the no action alternative, the mine would not be constructed, block-caving would not occur, and there would be no impacts from subsidence, induced seismicity, increased potential for landslides or rockfall, impacts on caves, karst, or paleontological resources, or impacts on mining claims.

3.2.4.2 Impacts Common to All Action Alternatives

Effects of the Land Exchange

The land exchange would have effects on geology and mineral resources.

The Oak Flat Federal Parcel would leave Forest Service jurisdiction. The role of the Tonto National Forest under its primary authorities in the Organic Administration Act, Locatable Regulations (36 CFR 228 Subpart A), and Multiple-Use Mining Act is to ensure that mining activities minimize adverse environmental effects on NFS surface resources. The removal of the Oak Flat Federal Parcel from Forest Service jurisdiction negates the ability of the Tonto National Forest to regulate effects on these resources from the proposed mine and block-caving. With respect to mineral development, no unpatented mining claims other than those associated with Resolution Copper are located on the Oak Flat Federal Parcel (see figure 1.3-2 in the GPO (Resolution Copper 2016d)).

The offered land parcels would enter either Forest Service or BLM jurisdiction. Section 3003 of the NDDA specifies that any land acquired by the United States is withdrawn from all forms of entry, appropriation, or disposal under the public land laws, location, entry, and patent under the mining laws, and disposition under the mineral leasing, mineral materials, and geothermal leasing laws.

Specific management of mineral resources on the offered lands would be determined by the agencies, but in general when the offered lands enter Federal jurisdiction, mineral exploration and development would not be allowed. Given these restrictions, no or little mine-related activity would be expected to occur on the offered lands.

Effects of Forest Plan Amendment

The Tonto National Forest Land and Resource Management Plan (1985b) provides guidance for management of lands and activities within the Tonto National Forest. It accomplishes this by establishing a mission, goals, objectives, and standards and guidelines. Missions, goals, and objectives are applicable on a forest-wide basis. Standards and guidelines are either applicable on a forest-wide basis or by specific management area.

A review of all components of the 1985 Forest Plan was conducted to identify the need for amendment due to the effects of the project, including both the land exchange and the proposed mine plan (Shin 2019). A number of standards and guidelines (18) were identified applicable to management of mineral, cave, or paleontological resources. None of these standards and guidelines were found to require amendment to the proposed project, either a forest-wide or management

area-specific basis. For additional details on specific rationale, see Shin (2019).

Summary of Applicant-Committed Environmental Protection Measures

A number of environmental protection measures are incorporated into the design of the project that would act to reduce potential impacts on geology and mineral resources or reduce potential impacts from subsidence and other geological hazards. These are non-discretionary measures, and their effects are accounted for in the analysis of environmental consequences.

In appendix E of the GPO (Resolution Copper 2016a), Resolution Copper has committed to various measures to reduce impacts from subsidence:

- Subsidence will be monitored to collect data to validate model calibration and refinements; to develop threshold and alarm levels for early warning and detection of subsidence impacts before surface impacts occur; to identify surface movements due to mining of the Resolution ore body; and to implement corrective actions and contingency plan.
    - Apache Leap, Queen Creek Canyon, and the surface area above the planned underground mine are currently monitored (prior to mining) using LiDAR, Interferometry Synthetic Aperture Radar (InSAR), and select rock spires using digital tilt meters.
    - During mining, the surface area above the ore deposit would be subdivided into a no-go zone, consistent with the limit of the subsidence fracture zone (where no person may enter) and a restricted public access zone consistent with the continuous subsidence limit (where Resolution Copper personnel are permitted for geotechnical monitoring and inspections). These zones would be reassessed during mining based on information collected from cave propagation monitoring.

      Surface subsidence will be monitored through the use of available industry best practice and demonstrated technology including, extensometer, survey prisms, crack displacement monitors; Time Domain Reflectometer (TDR) cables; aerial photography; InSAR; microseismic monitoring system; and smart markers and cave trackers.
    - Post-mining monitoring would continue for at least 15 years. Resolution Copper would continue to monitor the impact of surface subsidence on key infrastructures
        - Apache Leap, cliffs, and pillars
        - Queen Creek and Devil’s Canyons
        - Highway U.S. 60
        - The surface subsidence area and Oak Flat Campground
- Resolution Copper will document and store all the results of surface subsidence inspection and monitoring. Results will be reported annually to the Forest Service for the Apache Leap Special Management Area. The reporting would include a summary of subsidence management actions undertaken to protect the Apache Leap SMA, a summary of observed and/or reported subsidence impacts, and a summary of cave performance and subsidence development based on monitoring.

Additional applicant-committed environmental protection measures by Resolution Copper are identified in the draft subsidence monitoring plan (Tshisens 2018a) and would reduce impacts from subsidence to Apache Leap, Queen Creek Canyon, or Devil’s Canyon, staged depending on the level of effect observed:

- If monitoring indicates formation of new cracks or extension of existing cracks in the area, Harrison plots show slight damage based on monitoring data, small seismic events in the area, an average tilt up to 4 degrees, or measured subsidence angle is

between 72 and 78 degrees, measures implemented would be as follows:

- Resolution Copper would continue monitoring as per subsidence monitoring program; and
- Resolution Copper would update subsidence model predictions based on measured data or observations.

- If monitoring indicates extensive formation of new cracks or extension of existing cracks in the area; Harrison plots show moderate to severe damage based on monitoring data, major seismic events in the area, an average tilt of 5 degrees, or measured subsidence angle is less than 72 degrees; measures implemented would include the following:
    - Resolution Copper would increase monitoring frequency;
    - Resolution Copper would inform the Forest Service;
    - Resolution Copper would update subsidence model predictions based on measured data or observations; and
    - Resolution Copper would change draw strategy and mine plans.

Additional applicant-committed environmental protection measures by Resolution Copper would reduce impacts from subsidence to U.S. 60, mine roads and buildings, and Oak Flat Campground, staged depending on the level of effect observed (Tshisens 2018a):

- If monitoring shows formation of new cracks or extension of existing cracks in the area or on U.S. 60, Harrison plots show slight damage based on monitoring data, small seismic events in the area, an average angular distortion between 2×10^{-3} and $4\times10^{-3,}$ or measured subsidence angle is between 72 and 78 degrees; measures would include the following:
    - Resolution Copper would continue monitoring as per subsidence monitoring program; and
    - Resolution Copper would update the subsidence model predictions based on measured data or observations.
- If monitoring shows extensive formation of new cracks or extension of existing cracks in the area or on U.S. 60, Harrison plots show moderate to severe damage based on monitoring data, major seismic events in the area, an average angular distortion of more than $4\times10^{-3,}$ or measured subsidence angle is less than 72 degrees; measures implemented would be as follows:
    - Resolution Copper would increase monitoring frequency;
    - Resolution Copper would inform relevant public authorities;
    - Resolution Copper would update subsidence model predictions based on measured data or observations; and
    - Resolution Copper would increase road maintenance programs and repairs.

To prevent exposure of the public to geological hazards, Resolution Copper would use fencing, berms, locking gates, signage, natural barriers/steep terrain (25 to 30 percent or greater), and site security measures to limit access roads and other locations near areas of heavy recreational use.

Subsidence Impacts

TIMING AND EXTENT OF SUBSIDENCE CRATER DEVELOPMENT, INCLUDING UNCERTAINTY

Resolution Copper proposes to use panel caving for underground mining at about 4,500 to 7,000 feet beneath the ground surface. The total mineralized rock to be removed is estimated to be about 1.4 billion tons of ore. Caving of this ore material is induced by undercutting the ore zone, which removes its ability to support the overlying rock material.

Fractures then spread throughout the area to be extracted, causing it to collapse and form a cave, which then propagates upward. This caving of the ore is predicted to be accompanied by surface subsidence. Subsidence occurs when the underground excavation caves and movement of material propagate all the way to the surface, and the land surface is subsequently deformed.

The depth of the land surface depression is a result of the properties of the collapsed rock material and the amount of rock removed below it. The geographic extent of surface disturbance is a function of the rock properties, local geological structure, regional geological stresses, and the amount of material removed through mining. The predicted surface subsidence is depicted in figure 3.2.4-1, at 6, 10, 15, 20, 30, and 41 years after the start of mining.

Figure 3.2.4-1 illustrates three areas: the crater limit, fracture limit, and continuous subsidence limit.

- The crater limit is the area of active caving, directly above the ore body. The surface in this area would be actively mobilized and moving during mining. This is defined in the subsidence model as areas with more than 6 to 7 feet of vertical displacement.
- The fracture limit is at the fringe of the crater limit and is the area where visible fracturing would be expected, including radial cracks and possible rotation and toppling of rocks. For the purposes of the EIS analysis, the fracture limit is generally considered to be the area where physical impacts from subsidence are likely to occur. This area is defined in the subsidence model as areas where the total measure of strain exceeds 0.5 percent.
- The continuous subsidence limit is characterized by extremely small rock deformations that can only be detected using high-resolution monitoring equipment. If deformations are significant enough, in some cases they can create small hairline cracks in the surface of concrete but would not be visible in the soil or on the ground. This area is also commonly referred to as the elastic zone, because the deformations are usually below the threshold where rock fractures. This area is defined in the subsidence model by a combination of horizontal strain and angular distortion.

Figure 3.2.4-2 provides a detailed depiction of the anticipated subsidence at the end of the mine life; the fracture limit is estimated to extend to within approximately 1,115 feet (340 m) from Apache Leap, and to approximately 3,445 feet (1,050 m) from Devil's Canyon. The fracture limit area is roughly 1.8 miles in diameter.

The Geology and Subsidence Workgroup requested a number of sensitivity model runs as part of the evaluation of the subsidence model (BGC Engineering USA Inc. 2018a; Garza-Cruz and Pierce 2018). These model runs assess what would change if various input parameters or assumptions in the model were different, including rock mass strength, in-situ strength, fault strength, and bulked rock porosity. The size of the fracture limit under these different sensitivity runs does not differ substantially from the base case model, and while at least one sensitivity run brings it closer to the boundary of the Apache Leap SMA, it remains outside that boundary. Similarly, under all scenarios the first breakthrough of subsidence occurs in year 6 or 7 of mining, and subsidence ends very soon after ore extraction ends.

The primary difference in results among all the sensitivity model runs is the ultimate depth of the subsidence crater. Under the base case model, an ultimate depth of about 800 feet is anticipated. Under other sensitivity runs, the depth of the subsidence crater can vary between 800 and 1,115 feet.

POTENTIAL IMPACTS ON APACHE LEAP AND OTHER RESOURCES

While the fracture limit predicted by the subsidence model remains distant from Apache Leap, and Resolution Copper modelers concluded that there would be no anticipated damage to Apache Leap, there are still smaller modeled changes that are anticipated for Apache Leap. The

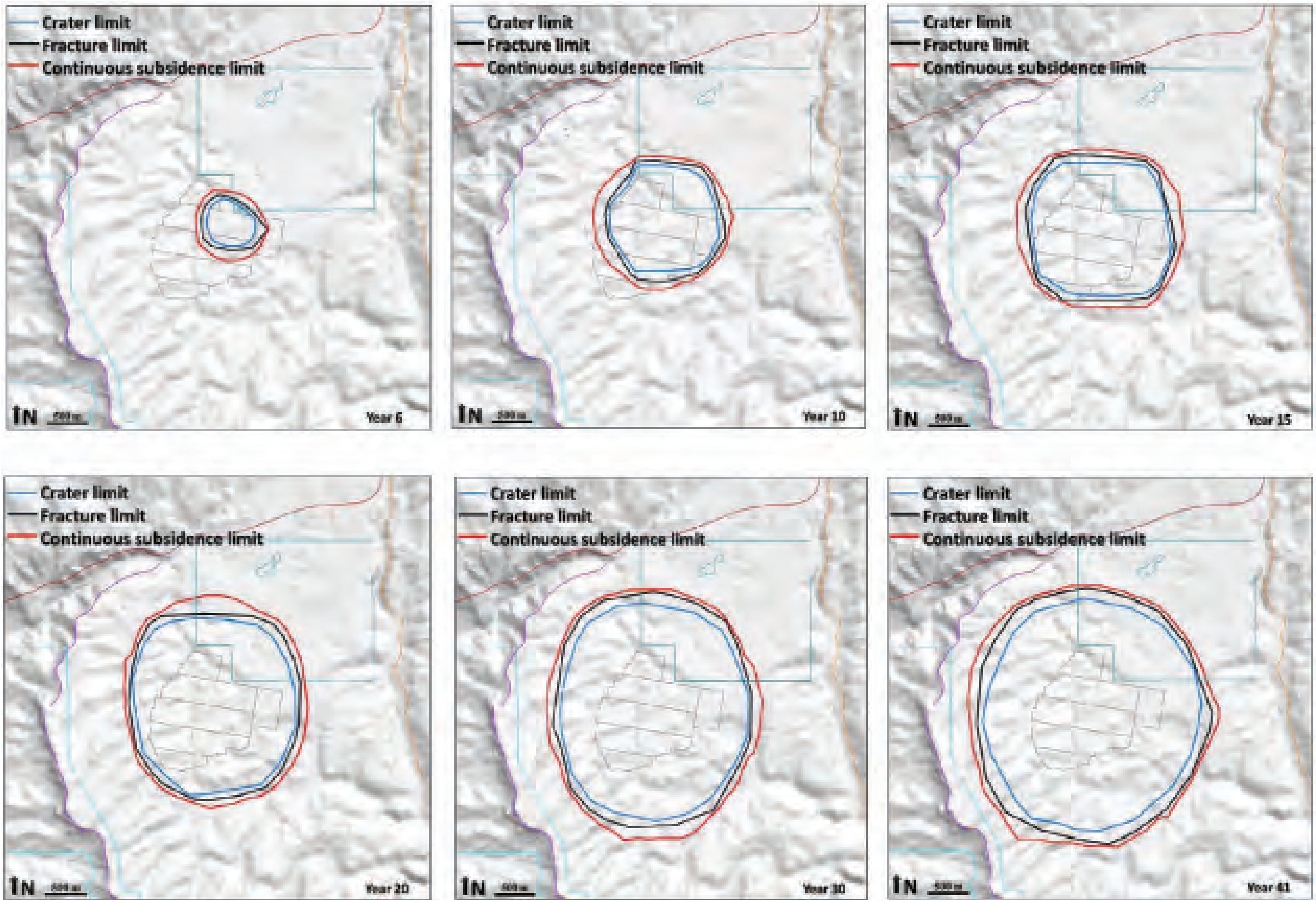


Figure 3.2.4-1. Evolution over time of the crater, fracture, and continuous subsidence limits predicted to exist (reproduced from Garza-Cruz and Pierce (2017))

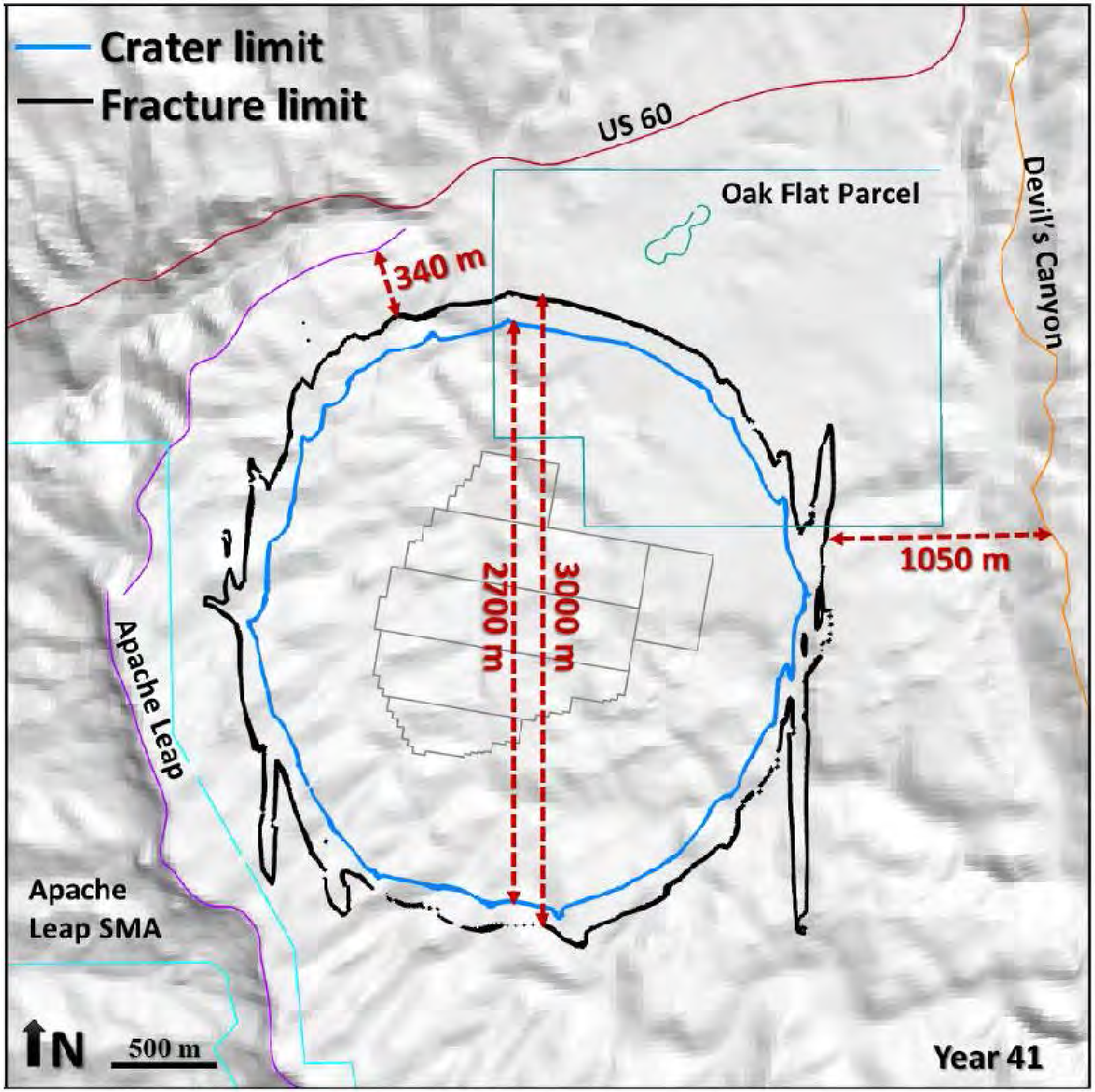


Figure 3.2.4-2. Final anticipated subsidence crater boundaries at end of mine life (reproduced from Garza-Cruz and Pierce (2017))

Geology and Subsidence Workgroup assessed predictions of horizontal displacement, vertical displacement, strain, and angular distortion.

- Roughly 1.5 feet (0.4 to 0.5 m) of horizontal and vertical displacement is anticipated at Apache Leap. Horizontal and vertical displacement by itself does not necessarily lead to damage.
- The angular distortion at Apache Leap is anticipated to be less than 1×10^{-3} meter/meter (BGC Engineering USA Inc. 2018a; Morey 2018b). The approximate threshold for damage is 3×10^{-3}, indicating that damage would not be expected at Apache Leap (BGC Engineering USA Inc. 2018a; Garza-Cruz and Pierce 2017).

The Geology and Subsidence Workgroup generally agreed with the conclusion that damage to Apache Leap would not be anticipated and found that many of the modeling choices were conservative (i.e., these choices would tend to overestimate the extent of subsidence, not underestimate it). However, after assessing a number of sensitivity analyses, some remaining uncertainties were recognized, including (BGC Engineering USA Inc. 2018a):

- The geographic extent of subsidence changes with the rock mass properties of the Apache Leap Tuff and Whitetail Conglomerate formations. When rock mass properties were reduced by 25 percent during a sensitivity run, the fracture limit extended closer to Apache Leap. However, even during this sensitivity run, angular distortion at Apache Leap did not exceed the 3×10^{-3} threshold for damage.
- The geographic extent of subsidence also changes with assumed fault strength. When fault strength was reduced during a sensitivity run, the fracture limit extended closer to Apache Leap. However, even during this sensitivity run, angular distortion at Apache Leap did not exceed the 3×10^{-3} threshold for damage.

Considering these uncertainties, the Geology and Subsidence Workgroup identified that the combination of horizontal displacement and vertical settlement could potentially cause angular distortion to locally exceed the damage threshold at Apache Leap and lead to localized rock block failure, but large-scale failures are not anticipated (BGC Engineering USA Inc. 2018a). A localized rock block failure refers to the gradual movement or sudden fall of one or more individual rock blocks due to progressive ground movement over time; these small rockfalls are a possibility but not anticipated to be substantially different from those observed in ongoing monitoring. Large-scale failure refers to progressive or sudden failure of a large mass of rock in response to ground movements over time; large failures, collapses, or major rockfalls are not anticipated and are considered to be unlikely.

In addition to Apache Leap, similar concerns were raised for Devil's Canyon and U.S. 60. These locations are located even farther than Apache Leap from the fracture limit. Damage is not anticipated at these locations, subject to the same uncertainties described in this section.

MINE INFRASTRUCTURE AND EFFECT OF SUBSIDENCE MONITORING

As noted, a number of applicant-committed environmental protection measures related to subsidence monitoring would occur. The intent of this monitoring is to understand the real-world progression of the block-caving and subsidence. Public comments have raised the concern that once block-caving begins, such monitoring would provide useful information but would ultimately not be effective at preventing impacts on Apache Leap or other areas if the subsidence modeling turns out to be incorrect.

While it is accurate that subsidence would progress unchecked once block-caving begins, there are several aspects of the mine plan that would make the subsidence monitoring effective at preventing damage to Apache Leap or U.S. 60.

The mine plan calls for the block-caving to occur in six discrete panels, described in detail in GPO section 3.2.9.1 (Resolution Copper 2016d).

The phasing of these panels is to mine from east to west, or in other words, starting farther from Apache Leap and working toward Apache Leap. In this manner, the results of subsidence monitoring from the initial panel caving would be available prior to any mining near Apache Leap. This would allow time for modifications to be made to the mine plan, if necessary, before damage occurred at Apache Leap.

In addition, the primary mine infrastructure at the East Plant Site is located closer to the subsidence fracture limit than Apache Leap. In the event that real-world subsidence is more extensive than anticipated by the subsidence modeling, the infrastructure needed to continue mining would be anticipated to be impacted prior to impacts occurring at Apache Leap. This would allow time for modifications to be made to the mine plan before damage occurred at Apache Leap.

Geological Hazards

INDUCED SEISMICITY

In general, the primary requirement for inducing seismicity is human activity that changes the state of stress in highly pre-stressed rocks (Gibowicz and Lasocki 2001); mining and subsidence at the project site could impact the existing state of stress. The potential for induced seismicity was assessed for the project (BGC Engineering USA Inc. 2018b).

It is not possible to make specific predictions about mine-induced seismicity at the proposed Resolution Copper Mine. However, the potential surface effects for induced earthquakes that might occur at the proposed mine could include ground shaking on a local scale, which could include the town of Superior. While mine-induced seismicity is possible, based on 100 years of worldwide observations, events greater than magnitude 5 are rare, and events of magnitude 3 or less are more common. This is observed in the most recent mine-related earthquakes in Arizona, which ranged from magnitude 2.9 to 3.1. For reference, damage to structures is rarely observed for earthquakes less than magnitude 5. Surface faulting is not expected because the magnitude of possible induced seismic events falls far below the observed threshold (about magnitude 6.5) for surface faulting (Youngs et al. 2003).

Induced mine seismicity is possible, but unlikely to be of sufficient magnitude to cause structural damage.

SUBSIDENCE AREA ACCESS

With the exception of the southeast portion, the entirety of the subsidence area would be on Resolution Copper private land, after exchange of the Oak Flat Federal Parcel. Access to the subsidence area would be restricted on these lands using fencing, berms, signage, and natural barriers or steep terrain (25 to 30 percent or greater).

The southeast portion of the subsidence area would be on Arizona State Trust land; the future ownership or use of this land is not known. Regardless of ownership, it is anticipated that the entire subsidence area would be under the jurisdiction of both the Arizona State Mine Inspector, requiring adherence to the Arizona mining code, and MSHA, requiring adherence to national mining regulations. Both these entities take public safety into account when regulating and inspecting mines and would dictate access restrictions.

Paleontological Resources

No known paleontological resources, or surface geological units amenable to paleontological resources (Naco, Escabrosa, and Martin limestones), would be impacted by subsidence or other activities at the East Plant Site, West Plant Site, MARRCO corridor, or filter plant and loadout facility.

Caves and Karst Resources

No known cave/karst resources, or surface geological units amenable to cave/karst resources (Naco and Escabrosa limestones), would be impacted by subsidence or other activities at the East Plant Site, West Plant Site, MARRCO corridor, or filter plant and loadout facility. Several caves have been identified in the vicinity of these facilities

(Umbrella Cave, Superior High School Cave); these are considered in section 3.8 as suitable wildlife habitat but would not be impacted or disturbed by the project footprint.

Unpatented Mining Claims

No unpatented mining claims unassociated with Resolution Copper would be impacted by activities at the East Plant Site, West Plant Site, MARRCO corridor, or filter plant and loadout facility.

The development of the Resolution Copper Mine potentially could encourage additional exploration and staking of mining claims on Federal lands at the periphery of the mine. This type of activity has been observed to be spurred by the permitting or development of known ore bodies. This ultimately could drive additional ground disturbance for well pads and access roads; any such development would be subject to Forest Service analysis and permitting. Known exploration projects have been considered for cumulative effects.

3.2.4.3 Alternative 2 – Near West Proposed Action

Paleontological Resources

No known paleontological resources have been observed within the footprint of the Alternative 2 tailings storage facility. Naco and Escabrosa limestone have not been observed at the surface under the Alternative 2 tailings storage facility footprint. A small outcropping of Martin limestone is located on the west side of the tailings storage facility footprint. Although paleontological resources have not been observed here, this geological formation has the potential to host fossils, and this outcrop likely would be destroyed during tailings storage facility construction (Klohn Crippen Berger Ltd. 2018a).

Caves and Karst

No known cave/karst resources, or surface geological units amenable to cave/karst resources (Naco and Escabrosa limestones), would be impacted by the footprint of the Alternative 2 tailings storage facility (Klohn Crippen Berger Ltd. 2018a).

Unpatented Mining Claims

A number of unpatented lode and placer claims are located within the footprint of the Alternative 2 tailings storage facility and tailings pipeline corridor footprint that are not associated with Resolution Copper (see figure 1.3-2 in the GPO). These include the Bomboy Placer claim and about 10 to 20 lode claims within the tailings storage facility footprint, along with 20 to 30 lode claims within the tailings pipeline corridor.

3.2.4.4 Alternative 3 – Near West – Ultrathickened

Impacts from Alternative 3 would be identical to those under Alternative 2 for caves, karst, paleontological resources, and mining claims.

3.2.4.5 Alternative 4 – Silver King

Paleontological Resources

No known paleontological resources, or surface geological units amenable to paleontological resources (Naco, Escabrosa, and Martin limestones), would be impacted by the footprint of the Alternative 4 tailings storage facility. All three of these units are in the vicinity but are not exposed at the surface within the tailings facility footprint (Klohn Crippen Berger Ltd. 2018c).

Caves and Karst

No known cave/karst resources, or surface geological units amenable to cave/karst resources (Naco and Escabrosa limestones), would be impacted by the footprint of the Alternative 4 tailings storage facility. Both of these units are in the vicinity but are not exposed at the surface within the tailings facility footprint (Klohn Crippen Berger Ltd. 2018c).

Unpatented Mining Claims

A number of unpatented lode claims are located within the footprint of the Alternative 4 tailings storage facility and tailings pipeline corridor footprint that are not associated with Resolution Copper. Roughly 70 to 80 unpatented claims, associated with three different owners, are within the tailings storage facility footprint.

3.2.4.6 Alternative 5 – Peg Leg

Paleontological Resources

No known paleontological resources, or surface geological units amenable to paleontological resources (Naco, Escabrosa, and Martin limestones), would be impacted by the footprint of the Alternative 5 tailings storage facility (Golder Associates Inc. 2018a).

Caves and Karst

No known cave/karst resources, or surface geological units amenable to cave/karst resources (Naco and Escabrosa limestones), would be impacted by the footprint of the Alternative 5 tailings storage facility (Golder Associates Inc. 2018a).

Unpatented Mining Claims

A number of unpatented lode claims are located within the footprint of the Alternative 5 tailings storage facility and tailings pipeline corridor footprint that are not associated with Resolution Copper. Roughly 80 to 90 unpatented claims, associated with two different owners, are located along the eastern tailings pipeline corridor, and roughly 40 to 50 unpatented claims, associated with five different owners, are located along the western tailings pipeline corridor.

3.2.4.7 Alternative 6 – Skunk Camp

Paleontological Resources

No known paleontological resources, or surface geological units amenable to paleontological resources (Naco, Escabrosa, and Martin limestones), would be impacted by the footprint of the Alternative 6 tailings storage facility (Klohn Crippen Berger Ltd. 2018d).

Caves and Karst

No known cave/karst resources, or surface geological units amenable to cave/karst resources (Naco and Escabrosa limestones), would be impacted by the footprint of the Alternative 6 tailings storage facility (Klohn Crippen Berger Ltd. 2018d).

Unpatented Mining Claims

While the Alternative 6 tailings storage facility is located on Arizona State Trust lands and private lands and therefore no Federal unpatented mining claims are present, a number of unpatented lode claims are located within the footprint of the Alternative 6 tailings pipeline corridor that are not associated with Resolution Copper. Roughly 120 to 130 unpatented claims, associated with three different owners, are located along the southern tailings pipeline corridor, and roughly 10 to 20 unpatented claims, associated with five different owners, are located along the northern tailings pipeline corridor.

3.2.4.8 Cumulative Effects

The Tonto National Forest identified the following reasonably foreseeable future actions as likely, in conjunction with development of the Resolution Copper Project, to contribute to cumulative impacts on geology, minerals, and subsidence. However, it should be noted that no other mining or other human activities in the cumulative impact assessment area were identified as likely to result in geological subsidence. The analysis presented here therefore focuses on effects on area geology and mineral resources. As noted in section 3.1, past and

present actions are assessed as part of the affected environment; this section analyzes the effects of any RFFAs, to be considered cumulatively along with the affected environment and Resolution Copper Project effects.

- *Pinto Valley Mine Expansion.* The Pinto Valley Mine is an existing open-pit copper and molybdenum mine located approximately 8 miles west of Miami, Arizona, in Gila County. Pinto Valley Mining Corporation is proposing to expand mining activities onto an estimated 1,011 acres of new disturbance (245 acres on Tonto National Forest land and 766 acres on private land owned by Pinto Valley Mining Corporation) and extend the life of the mine to 2039. The company estimates average annual copper production rates of between 125 and 160 million pounds to continue through the extended operational life of this mine.
- *Ripsey Wash Tailings Project.* ASARCO is planning to construct a new tailings storage facility to support its Ray Mine operations. The environmental effects of the project were analyzed in an EIS conducted by the USACE and approved in a ROD issued in December 2018. As approved, the proposed tailings storage facility project would occupy an estimated 2,574 acres and be situated in the Ripsey Wash watershed just south of the Gila River approximately 5 miles west-northwest of Kearny, Arizona, and would contain up to approximately 750 million tons of material (tailings and embankment material). ASARCO estimates a construction period of 3 years and approximately 50 years of expansion of the footprint of the tailings storage facility as slurry tailings are added to the facility, followed by a 7- to 10-year period for reclamation and final closure. The effects of this project on geology and minerals would include what is assumed to be irreversible loss to future use of any aggregate (i.e., sand, gravel, or decorative rock) or other mineral resource that would be permanently buried beneath the estimated 625-foot-high, nearly 2,600-acre facility.
- *Ray Land Exchange and Proposed Plan Amendment*. ASARCO is also seeking to complete a land exchange with the BLM by which the mining company would gain title to approximately 10,976 acres of public lands and federally owned mineral estate located near ASARCO's Ray Mine in exchange for transferring to the BLM approximately 7,304 acres of private lands, primarily in northwestern Arizona. It is known that at some point ASARCO wishes to develop a copper mining operation in the "Copper Butte" area west of the Ray Mine; however, no specific details are currently available as to potential environmental effects resulting from this future mining operation. Also, while no data have been made publicly available regarding ASARCO's estimates of the overall size or estimated grade of the ore body at the Copper Butte location, the deposit is known to be relatively shallow and composed entirely or nearly entirely of oxide ore. ASARCO has stated that the ore would be mined via an open-pit operation.
- *Florence Copper In-Situ Mining Project.* This mining project, located on the northwestern outskirts of the town of Florence, is an underground copper leaching, recovery, and processing operation that is now in a production testing phase. The operational life of the mine is estimated at approximately 20 years. The mine owner, Florence Copper, estimates that the operation would produce an average of 55 million pounds of copper annually for the first 6 years and 85 million pounds annually for 14 years, equating to approximately 1.5 billion pounds of copper that would be permanently removed from this location.

With respect to these RFFAs, although no Resolution Copper Project effects from subsidence, geological hazards, paleontological resources, or cave/karst resources would overlap the effects from these mining projects, cumulatively, all would contribute to the overall regional effects of continued mineral extraction in the Copper Triangle. It is reasonable to assume that during the projected life of the Resolution Copper Mine (50–55 years), some mineral material extraction operations like the mines identified here may exhaust the supply of desired rock materials

in a given location and close, while other similar operations may start up elsewhere within the cumulative effects analysis area.

At any given time in this region of Arizona, it is extremely common for various mineral exploration projects, often involving the drilling of assay or test boreholes to evaluate the potential presence of an economically valuable mineral resource, to be ongoing. However, these types of activities are nearly always short term (typically lasting a few weeks to a few months) and generally have no effect or only the most negligible effect on the landscape and on area geological and mineral resources. It is reasonable to assume similar activities will continue into the foreseeable future.

3.2.4.9 Mitigation Effectiveness

The Forest Service is in the process of developing a robust mitigation plan to avoid, minimize, rectify, reduce, or compensate for resource impacts that have been identified during the process of preparing this EIS. Appendix J contains descriptions of mitigation concepts being considered and known to be effective, as of publication of the DEIS. Appendix J also contains descriptions of monitoring that would be needed to identify potential impacts and mitigation effectiveness. As noted in chapter 2 (section 2.3), the full suite of mitigation would be contained in the FEIS, required by the ROD, and ultimately included in the final GPO approved by the Forest Service. Public comment on the DEIS, and in particular appendix J, will inform the final suite of mitigations.

This section contains an assessment of the effectiveness of mitigation and monitoring measures found in appendix J that are applicable to geology, minerals, and subsidence.

Mitigation Measures Applicable to Geology, Minerals, and Subsidence

Subsidence monitoring plan (FS-222): Extensive subsidence monitoring has been proposed by Resolution Copper and is included in this document as an applicant-committed environmental protection measure, as discussed earlier in this resource section under “Summary of Applicant-Committed Environmental Protection Measures.” The Forest Service generally has concluded that this monitoring would be effective at identifying potential effects of subsidence in time to inform a response to prevent damage.

However, as subsidence has the potential to affect Tonto National Forest surface resources, particularly within the Apache Leap SMA, the Forest Service will require that a final subsidence monitoring plan be completed and approved by the Forest Service prior to signing a decision. Given the unique and technical nature of subsidence modeling and monitoring, the Forest Service would engage with appropriate industry professionals (such as those involved in the Geology and Subsidence Workgroup) to review the subsidence monitoring plan, funded by Resolution Copper if deemed appropriate.

Mitigation Effectiveness and Impacts

The mitigation measure would focus on all aspects of the subsidence monitoring, including monitoring equipment, techniques, frequency, trigger levels, and remedial actions. As discussed earlier, the phasing of the panel caving is such that remedial actions can be taken if monitoring indicates subsidence impacts are more extensive than anticipated. The final subsidence monitoring plan is therefore anticipated to be effective at mitigating any damage to Apache Leap or other Tonto National Forest surface resources, once appropriate trigger levels and actions have been identified.

There would be no additional physical impacts associated with this mitigation.

Unavoidable Adverse Impacts

Unavoidable adverse impacts would occur through disturbance caused by the subsidence, to a small area of Martin limestone with potential paleontological resources (Alternatives 2 and 3), and to unpatented mining claims not associated with the Resolution Copper Project (all tailings facilities and/or pipeline corridors). Impacts on cave/karst

resources and to the public from geological hazards from access to the subsidence area, induced seismicity, or damage to Apache Leap are not considered likely to occur.

3.2.4.10 Other Required Disclosures

Short-Term Uses and Long-Term Productivity

Construction of the project would convert some undeveloped lands into an industrial mining operation, and construction of mine facilities would alter the area's topography. Impacts related to subsidence and the tailings storage facilities would permanently impact long-term productivity.

Irreversible and Irretrievable Commitment of Resources

Irreversible commitment of geological and mineral resources would occur with the excavation and relocation of approximately 1.4 billion tons of rock and with the recovery of approximately 40 billion pounds of copper, as well as the burying of any mineral resources below the alternative tailings facilities.

With respect to paleontological and cave/karst resources, a commitment of resources is considered to be irretrievable when project impacts limit the future use or productivity of a nonrenewable resource over a limited amount of time—for example, structures built on top of paleontologically sensitive geological units that might later be removed. A commitment of resources is considered to be irreversible when project impacts cause a nonrenewable resource to be permanently lost—for example, destruction of significant fossils and loss of associated scientific data.

An irreversible commitment of paleontological resources could occur at the Alternative 2 and 3 tailings storage facility location, where potentially fossil-bearing rocks associated with the Martin limestone could be destroyed in site preparation or buried permanently.

Overview

The proposed mine would disturb large areas of ground, not only from the mining and processing facilities, but also from the subsidence crater and tailings storage facility. Ground disturbance has the potential to destroy native vegetation, including species given special status by the Forest Service, and encourage noxious or invasive weeds. Ground disturbance also affects soils. Soils are a nonrenewable resource and can experience long-term impacts through compaction, accelerated erosion, and loss of productivity. After closure of the mine, reclamation can partially restore the function of these disturbed areas, but success depends on the stability of the tailings, on the closure design, and on how readily vegetation can be reestablished.

3.3 Soils and Vegetation

3.3.1 Introduction

This section discusses the effects of the project on soils, soil productivity, vegetation communities, noxious and invasive weeds, and special status plant species. Soils, which comprise mineral and organic material, provide the necessary structure, water, gases, and nutrients needed to support diverse microbial communities and growth and propagation of plants. Ground disturbance would potentially remove or destroy soil cover and vegetation, directly and indirectly impacting the quality, health, integrity, and stability of a soil, thereby degrading its productivity and capacity to sustain plant growth.

Soil and vegetation work together to form and support an ecosystem. The project would fundamentally change large areas of the landscape and remove these ecosystems for decades during the life of the mine. However, during reclamation and closure, these ecosystems can be recovered to a degree in some areas, particularly at the tailings storage facility. This section identifies what these ecosystems look like today, the management vision for how these ecosystems ideally would function in the long term (also known as the desired condition), and an assessment of whether the tailings landform can reach desired conditions over the long term, through reclamation and revegetation efforts.

3.3.2 Analysis Methodology, Assumptions, and Uncertain and Unknown Information

3.3.2.1 Analysis Area

This section includes a discussion of soils, revegetation, vegetation communities, special status plant species, and noxious weeds. The project area footprint (including all alternatives and facility components) is the analysis area for soils, soil productivity, and revegetation potential, as it encompasses all ground-disturbing activities. The analysis area for vegetation communities, noxious and invasive weeds, and special status plant species includes the project footprint with a 1-mile buffer, as well as areas along Queen Creek and Devil's Canyon, where changes to vegetation communities from groundwater drawdown and changes in surface water hydrology may occur. The soils analysis area is shown in figure 3.3.2-1, and the vegetation analysis area is shown in figure 3.3.2-2.

The area beyond the project footprint is informed by the water analyses for riparian areas (analyzed in section 3.7.1), reduction in surface runoff due to the project (analyzed in section 3.7.3); air quality analyses, particularly those focused on the generation and likely dispersion of fugitive dust (analyzed in section 3.6); lighting effects (analyzed in section 3.11), and the potential for noxious weed invasion (Foxcroft et al. 2010). According to the air quality analysis, ambient air quality standards would be achieved at the project footprint boundaries; for that reason, the 1-mile buffer is

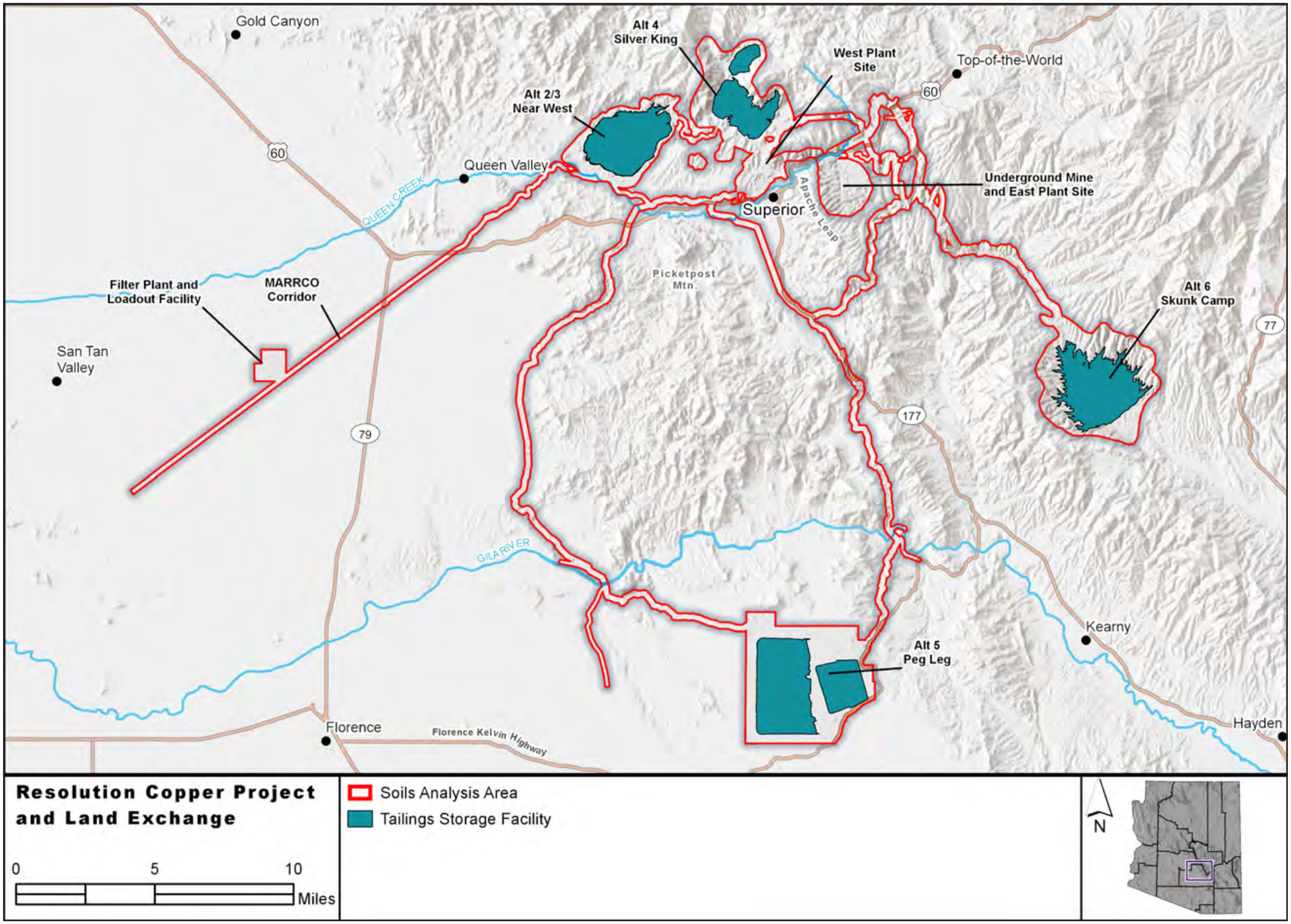


Figure 3.3.2-1. Soils analysis area

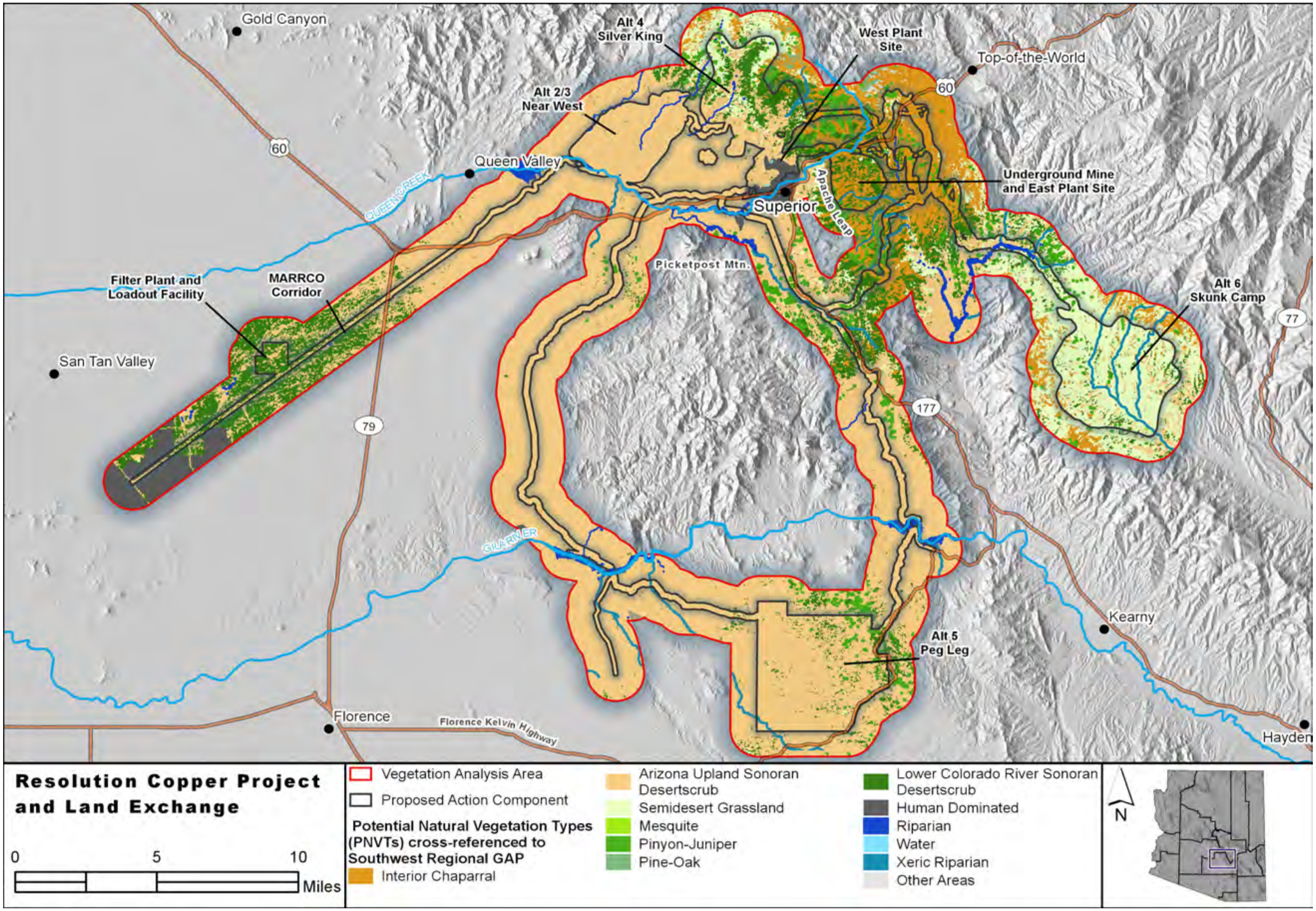


Figure 3.3.2-2. Vegetation analysis area

sufficient to address potential impacts from ambient air quality changes. Additional light associated with project construction and facilities is anticipated to increase night sky brightness by 1 to 9 percent (Dark Sky Partners LLC 2018). With the additional light increase of 1 to 9 percent over existing conditions, the 1-mile buffer would be sufficient to capture potential project-related impacts on plants from additional light.

The temporal parameters for this analysis involved the time frames for (1) construction: mine years 1 through 9; (2) operation: mine years 6 through 46; and (3) closure and reclamation: mine years 46 through 51–56. This analysis also extends to the time it takes to complete reclamation, because arid soils and vegetation communities in the analysis area can take very long periods (hundreds to thousands of years) to recover and reestablish; in some cases, complete recovery may not be possible.

3.3.2.2 Soils Analysis

The goal of the soils analysis is to identify the potential impacts on soil resources from all project activities and alternatives. In this analysis, soils are considered nonrenewable resources, as their formation in desert environments (particularly those characteristics that control biological community establishment) takes place over hundreds to thousands of years (Webb et al. 1988; Williams et al. 2013). Soil losses within the project footprint are, therefore, treated as permanent unless (1) soils are salvaged and reapplied during the construction and reclamation processes, (2) revegetation efforts successfully stabilize soils and reduce long-term erosion, and (3) soil productivity is returned to pre-mine conditions.

No single data set covers the entire project footprint; therefore, two data sources were combined for the soils analysis: (1) the U.S. Department of Agriculture (USDA) National Resources Conservation Service (NRCS) Soil Survey Geographic (SSURGO) database (2017); and (2) the Forest Service General Terrestrial Ecosystem Survey (GTES) (U.S. Forest Service 2018e), applied where SSURGO data were unavailable. Where available, SSURGO data (Natural Resources Conservation Service 2017) provided information regarding general soil morphological characteristics, soil depth, soil productivity, soil fertility, and soil wind and water erosion potential (Natural Resources Conservation Service 2018b). For this analysis, soil productivity is defined as “capacity of soil, in its normal environment, to support plant growth” (Minnesota Forest Resources Council 1999). GTES data provide some information on erosion susceptibility in other areas (U.S. Forest Service 2018e). In areas lacking SSURGO data, information regarding the nature and thickness of alluvial deposits and soil cover was taken from the “Near West Tailings Storage Facility Geotechnical Site Characterization Report” (corresponding directly to Alternatives 2 and 3) and extrapolated to other alternatives (Klohn Crippen Berger Ltd. 2017). Data and interpretations could be reasonably extrapolated across alternatives, as all sites occur within similar ecosystems of central Arizona. Site-specific interpretations of soil map units and erosion potential are limited by the resolution and accuracy of GIS data, which varied by data source and survey effort. Details of the soils analysis approach are available in Newell (2018g).

3.3.2.3 Revegetation Analysis

The goal of the revegetation analysis is to provide a site-specific assessment of current conditions and guidance for future revegetation efforts throughout the life of the project. Revegetation success depends on several controlling environmental variables (precipitation or water availability, climate, soil or revegetation substrate, reclamation techniques, etc.); therefore, no individual study includes enough information to project rates of revegetation success. For this analysis, a meta-analysis drew data from many sources to model revegetation rates. The analysis does not reflect outcomes for individual project components but instead relies on conceptual reclamation plans and provides a range of possible revegetation outcomes that could be expected at a given time after reclamation has commenced. The first step in the meta-analysis was to gather relevant case studies from published scientific literature, technical reports, and semi-quantitative field observations. Two attributes were compiled from each study: (1) the number of years since reclamation commenced, and (2) the minimum and maximum observed percent vegetation cover at the given time.

The results from each study were combined into a single plot for visual interpretation. Details of the data sources and the analysis approach are provided in Bengtson (2019b).

The assessment of revegetation relies in part on the reclamation plans that have been prepared by Resolution Copper, both as part of the GPO (section 6.0) and during alternatives development for the different tailings storage facilities. These reclamation plans largely describe the expected timing, type, and location of reclamation activities and provide the reclamation goals to be achieved. These conceptual reclamation plans are briefly summarized in this section.

A further level of reclamation detail would be developed in the final reclamation plans approved by the Forest Service and used to guide bonding estimates. As an example, the GPO identifies only that reseeding would occur and proposes a likely seed mix. Details in the final reclamation plan would identify surface preparation (ripping or tilling), site amendments (straw or fertilizers), a final seed mix, whether, where, and how any direct planting would be done, the need for supplemental watering, and performance standards that would need to be met through monitoring of revegetation progress.

3.3.2.4 Vegetation Communities, Noxious Weeds, and Special Status Plant Species Analysis

This analysis identifies the potential impacts on vegetation, vegetation communities, and special status plant species from all activities associated with each project alternative, including closure and reclamation (see table E-1 in appendix E for details associated with each alternative). The analysis also evaluates the increased likelihood of introduction and/or spread of noxious weed species in the analysis area.

The factors for analysis identified during the NEPA scoping process, survey, and records data provided as part of this project, as well as a scientific examination using current literature on species and how environmental changes (human or natural) affect species and their habitat, constitute the foundation of this analysis.

The uncertainties and unknown information, as well as assumptions, of this analysis include (1) limitations in the use of geographic information system (GIS) data (e.g., mapping data may have inaccuracies and resulting calculations could be an overestimation or underestimation) or data come from different sources for different portions of the analysis area; however, the analysis area contains similar overall environments and data sources have been reasonably extrapolated to cover the entire analysis area; (2) lack of current scientific data on how certain environmental changes affect species (e.g., there are only a few studies available regarding dust effects on plants); and (3) reliance on other, previous resource analyses as informational sources for the conclusions reached in this current analysis may inadvertently reiterate the assumptions, uncertainties, or unknown information inherent in these prior studies.

The analysis of reclamation success relies in part on the desired conditions for the lands, which are the expectations for how the landscape should appear and function over the long term. For the purposes of this analysis, desired conditions were informed by internal work by the Tonto National Forest on the ongoing revision to the forest plan, which has not yet been completed or released. The desired conditions used in this section are meant to allow an assessment of reclamation success but should not be construed as management direction from the Tonto National Forest.

3.3.3 Affected Environment

3.3.3.1 Relevant Laws, Regulations, Policies, and Plans

A summary of the principal legal authorities pertinent primarily to reclamation is shown in the accompanying text box. A complete listing and brief description of the laws, regulations, reference documents, and agency guidance used in this soils and vegetation effects analysis may be reviewed in Newell (2018g).

Primary Legal Authorities Relevant to the Soils and Vegetation Effects Analysis

- Forest Service locatable mineral regulations (36 CFR 228 Subpart A), specifically:
  - Minimizing adverse environmental impacts on NFS surface resources (36 CFR 228.8)
  - Requirements for reclamation (36 CFR 228.8(g))
- Forest Service Manual 2500, Chapter 2550 – Soil Management
- Arizona Native Plant Law (ARS 3-904)
- Federal Noxious Weed Act of 1974
- Arizona Mined Land Reclamation Program
- State of Arizona Noxious Weed Statute
- Taylor Grazing Act (43 U.S.C. 315-315(o))
- Federal Land Policy and Management Act of 1976 (43 U.S.C. 1701–1782)

3.3.3.2 Existing Conditions and Ongoing Trends

Soil Occurence and Characteristics

The project area footprint, including all components and alternatives, is characterized by Basin and Range geomorphology (Peterson 1981), with soils of formed in alluvium, eolian deposits, colluvium, and thin residuum (overlying bedrock outcrops). In general, the deepest soils are formed within expansive alluvial fan piedmonts or alluvial deposits within the bottoms of canyons. Shallower soils form as thin alluvial or colluvial deposits along ridges and hillslopes (overlying shallow bedrock), or as shallow soils overlying calcium carbonate-cemented horizons (petrocalcic horizons) that form root-restrictive layers.

There are 42 soil units mapped in the analysis area (including the combination of map units from SSURGO and GTES datasets), with the majority of these individual map units being minor and constituting less than 1.0 percent of the area of each alternative. These map units are delineated in figure 3.3.3-1. The predominant soil units mapped for each action alternative are detailed in table 3.3.3-2, which includes descriptions of each predominant map unit's morphological characteristics, soil depths, soil productivity (either annual biomass production or dominant vegetation community), and soil fertility. Areas covered by SSURGO (Natural Resources Conservation Service 2017) data contain the most detailed soil descriptions, whereas data from other sources were used to extrapolate soils-related data to areas covered by GTES data (U.S. Forest Service 2018e). Data provided later in table 3.3.3-2 include only predominant soil map unit information; details of acreages of all individual map units are provided in Newell (2018g). Soil mapping is at an insufficient scale to delineate the location of each soil unit with respect to a specific disturbance feature for each alternative.

Soils across all project alternatives display characteristics that are unique to arid and semi-arid environments, which influence ecological function and response to disturbance. For example, soil resources such as water and nutrients display extreme variation through space and time, as pulses in precipitation drive pulses in biological and chemical cycles and processes (Abella 2017). Arid and semi-arid soils display distinct surface features such as desert pavements and biotic soils that provide critical

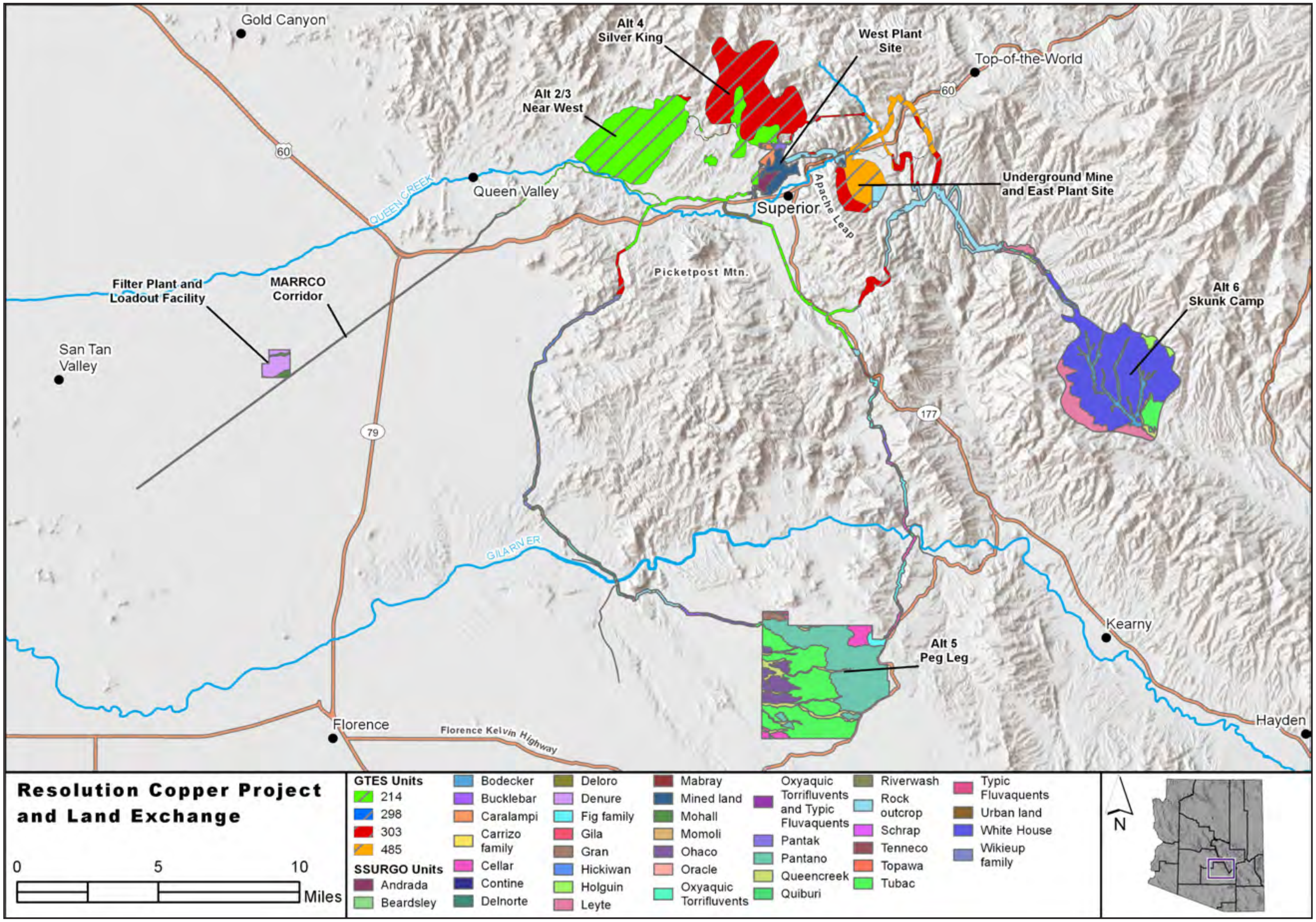


Figure 3.3.3-1. Soil map units as delineated from SSURGO (Natural Resources Conservation Service 2017) GTES (U.S. Forest Service 2018e) datasets

soil cover (in areas where vegetation is sparse) and play an active role in the capture of dust and formation of dust-rich vesicular horizons, which strongly influence the distribution and storage of water (Williams 2011; Williams et al. 2013). Desert pavements form a single layer of surface rock fragments that resemble smooth pavement surfaces (Wood et al. 2005), whereas biotic soils formed by cyanobacteria, mosses, lichens, bacteria, algae, and fungi that grow around soil mineral particles create a living soil cover (Eldridge and Greene 1994; Williams et al. 2012).

Fertile islands are also ubiquitous surface features in these soils, where nutrients, organic material, macro- and microbiological activity, and water availability are elevated in surface soils beneath the canopies of perennial vegetation as compared with the soils of surrounding plant interspaces (Schlesinger et al. 1996). Surface soils further contain soil seedbank, which in most deserts is limited to the upper 2 inches of soil (Scoles-Sciulla and DeFalco 2009). Surface topography and soil cover drive the distribution of water and infiltration across arid soil surfaces in arid environments. Soil water runs off smooth surfaces with low infiltration only to be captured along rougher surfaces with greater infiltration potential and stored where soil water-holding capacity is high (Wood et al. 2005). Similarly, slope drives the redistribution of water, with drainages capturing and storing the majority of water run-off, leading to different community composition in those areas than adjacent upland areas (Schwinning et al. 2010).

Note that where specific soil data are shown to be lacking, several mitigations are required that would provide for collection of this information (see section 3.3.4.9).

Soils Suitability for Reclamation

According to the GPO (Resolution Copper 2016d), soils within much of the project footprint (particularly those within Alternatives 2 and 3) are primarily bedrock-controlled, and only a thin veneer of soils could be salvaged for previous reclamation and revegetation efforts (Resolution Copper 2016d). The GPO states that, where possible, soil would be salvaged for reuse during reclamation. The geotechnical study for the Near West tailings storage facility (Klohn Crippen Berger Ltd. 2017) has identified thick alluvial deposits in drainages within the footprint and borrow areas of the proposed facility (alluvial deposits 6 to 35 feet thick); however, the alluvium has been allocated for construction of drains and filters. These bedrock-controlled soils (alluvium and colluvium up to 5 feet in thickness (Klohn Crippen Berger Ltd. 2017)) and thicker alluvial soils in drainages are typically capable of supporting vegetation communities ranging from Arizona Upland Sonoran Desertscrub and to Interior Chaparral Semi-desert Grassland (table 3.3.3-3).

Alternative 5 has both shallow, bedrock-controlled soils (up to 20 inches deep) and deeper soils formed along alluvial fan terraces (more than 60 inches deep). These soils have low organic matter (approximately 1 percent) and near neutral to slightly alkaline pH conditions that support annual rangeland productivity ranging from 350 to 600 lb biomass/acre/year (Natural Resources Conservation Service 2017).

Alternative 6 has both bedrock-controlled soils (alluvium and colluvium up to 5 feet in thickness (Klohn Crippen Berger Ltd. 2017) and deeper soils formed in alluvial fans (more than 60 inches deep) (Natural Resources Conservation Service 2017). These soils have low organic matter (approximately 1 percent) and slightly acidic to slightly alkaline pH conditions that support annual rangeland productivity ranging from 600 to 800 lb biomass/acre/year (Natural Resources Conservation Service 2017).

While some volume of soils would be salvaged (as practicable) for project reclamation, most of the capping material for the proposed tailings storage facility would be derived from other sources. The closure cover study completed for the Near West tailings storage facility (Klohn Crippen Berger Ltd. 2016) identified Gila Conglomerate as the preferred closure material for reclamation within the Near West tailings storage facility, which is present in sufficient quantities to be the primary capping material (for this facility's alternative). Gila Conglomerate was selected for the following reasons (Klohn Crippen Berger Ltd. 2016):

1. availability of material and ease of extraction,
2. favorable chemical and physical properties, and
3. its potential to support plant growth.

The characteristics of this material as a closure material and plant growth medium are described in more detail in Bengtson (2019a). In general, Gila Conglomerate is a neutral to slightly alkaline material (pH 7 to 8.2), is not potentially acid generating, and has a high net neutralization potential (Klohn Crippen Berger Ltd. 2016). Gila Conglomerate has both high saturated hydraulic conductivity and low water-holding capacity. Organic matter ranges from 1.6 to 3.2 percent (Klohn Crippen Berger Ltd. 2016). Total Nitrogen ranges from less than 0.02 to 0.028 percent, and organic carbon ranges from 1.6 to 3.2 percent[24] (Klohn Crippen Berger Ltd. 2016). Gila Conglomerate bedrock and soils formed from Gila Conglomerate parent material have been shown to support native and warm- and cool-season perennial grasses, annual forbs, and perennial forbs, some shrubs, and trees (Lawson 2012; Lawson 2011; Milczarek et al. 2011; Romig et al. 2006; Vinson et al. 1999). Revegetation studies on Gila Conglomerate-derived soils have shown vegetation cover may range from 2.8 to 26 percent, less than 1 year after reclamation treatments were applied (Lawson 2012; Lawson 2011). For surfaces capped by crushed Gila Conglomerate bedrock, another study showed vegetation cover varied from 11 to 71 percent 1 year after treatment, and by year 12, vegetation cover ranged from 23 to 77 percent (Milczarek et al. 2011). These studies further indicate that soil amendments, such as organic amendments and mulch treatments, may help increase the success of revegetation when crushed Gila Conglomerate bedrock is the plant growth medium, by increasing soil water-holding capacity and soil fertility and decreasing erosion susceptibility (Klohn Crippen Berger Ltd. 2016; Lawson 2011; Milczarek et al. 2011; Vinson et al. 1999).

Note that while the materials described here have been demonstrated in other situations to be theoretically suitable for reclamation, at least to a degree, several mitigations are required that would provide for collection of additional information to inform final reclamation plans, including the overall suitability of these materials (see section 3.3.4.9).

Estimates of Salvage Volumes

The GPO identified different geological units that would be salvaged during site preparation as being favorable for different uses for final cover (see table 4.6-1 in Resolution Copper (2016d)):

- Alluvial material. Primarily used for drains and filters for seepage control.
- Apache Leap Tuff. Primarily used for drains and filters, and for armoring of tailings embankment and seepage control embankments.
- Gila Conglomerate. Used for starter dams, drains and filters, and closure cover.
- Pinal Schist. Primarily used for armoring of tailings embankment, seepage control embankment, and diversion channels.

With respect to the final reclamation cover, the GPO originally estimated that over 8,000 acre-feet (13 million cubic yards) of Gila Conglomerate material would be available for cover during reclamation for the proposed action (Alternative 2), based on salvage from two borrow areas of about 350 acres, roughly to a depth of about 20 feet. With the development of different tailings alternatives, the specific borrow areas have changed. The borrow areas and estimated amounts of closure cover material are summarized in table 3.3.3-1.

24. Gila Conglomerate samples analyzed for organic matter included: (1) 30 surface samples from Near West site (organic matter ranging from 1.6 to 3.2 percent), which could have been impacted by soil formation (i.e., organic additions from soil biological activity); and (2) 25 samples from the Superior Mine stockpile (organic matter content was 1.7 percent), which were blasted, crushed, and screened (the influence of soil biological processes on organic matter contents is unknown).

Table 3.3.3-1. Estimated locations and amounts of available reclamation cover material

	Alternatives 2 and 3	Alternative 4	Alternative 5	Alternative 6
Proposed borrow area acreage	209 acres (one location)	247 acres (one location)	721 acres (five locations)	390 acres (two locations)
Primary geology of borrow area	Gila Conglomerate	Gila Conglomerate	Alluvium and Gila Conglomerate; some granite	Gila Conglomerate
Estimated volume of cover material available*	4,180 acre-feet (6.7 million cubic yards)	4,940 acre-feet (8 million cubic yards)	14,400 acre-feet (23.2 million cubic yards)	7,800 acre-feet (12.5 million cubic yards)
Approximate depth of cover from borrow areas for tailings storage facility†	1.3 feet	2.2 feet	2.7 feet	1.8 feet

* Assumes excavation to depth of 20 feet

† Based on planar acreage of tailings storage facility. Accounting for slopes (at 3H:1V) would require minimal additional material (less than a 5% increase)

The conceptual reclamation plans for the tailings storage facilities call for a minimum of 1.5 feet of cover, and the borrow areas proposed are roughly sufficient to provide this material for the tailings storage facility. Additional cover material would be obtained from salvage of surface soils within the footprint of the facility.

Previous investigations have looked at the possibility of the closure cover being a mix of materials, such as Gila Conglomerate and NPAG tailings (Klohn Crippen Berger Ltd. 2016). Geochemical characterization tests have been conducted on these materials and identified that there may be some potential for elevated metals in stormwater runoff. See section 3.7.2 for details of the geochemical tests conducted for NPAG tailings, and tests on Gila Conglomerate have been described in several other reports (Klohn Crippen Berger Ltd. 2016, 2017).

Note that several mitigations are required that would provide for detailed estimates of soil available for salvage, salvaged soil storage techniques, potential preparation techniques (like excavation and crushing for Gila Conglomerate), conducting of appropriate tests to identify any potential water quality concerns for the selected cover material, and preparation of detailed reclamation plans that specify the cover materials to be used (see section 3.3.4.9). The predominant soil units mapped for each action alternative are detailed in table 3.3.3-2, which includes descriptions of each predominant map unit's morphological characteristics, soil depths, soil productivity (either annual biomass production or dominant vegetation community), and soil fertility.

Vegetation Occurrence and Characteristics

VEGETATION COMMUNITIES

Eleven vegetation communities and land cover types occur within the analysis area. These communities and land cover types along with the acres of each are given in table 3.3.3-3 and are shown in figure 3.3.3-2. The vegetation community GIS data used for this analysis comprised a specialized dataset developed by the Arizona Game and Fish Department (AGFD) that is a crosswalk between the larger scale (Brown 1994; Brown et al. 2007) and Southwest Regional Gap Analysis Project (SWReGAP) vegetation communities data and, more specifically, a modified SWReGAP layer that was used in the AGFD's statewide modeling process (Morey 2018a).

A brief description of each of the vegetation communities in the analysis area is provided here, with more technical description included in Newell (2018g). Within each alternative footprint, a variety of combinations of different vegetation communities are present. Note that where specific vegetation data are shown to be lacking, several mitigations are required that would provide for collection of this information (see section 3.3.4.9).

Table 3.3.3-2. Predominant soils by alternative

Alternative	Total Acres	Map Unit Symbol (data source)	Map Unit Name	Map Unit Description and Soil Composition	Productivity† (pounds of biomass per acre or dominant vegetation community)	Fertility‡	Acreage within Map Unit	Percentage of Alternative
Alternative 2 – Near West Proposed Action	10,033	214 (GTES)	CEMI2, LATR	Klohn Crippen Berger Ltd. (2017) identified the majority of soils and soil parent material within the Near West project footprint to be formed in Undifferentiated Quaternary Deposits (Qs).* These surfaces are covered in slope wash and colluvium, and recent alluvium in narrow drainages low-relief areas underlain by bedrock (up to 5 feet in thickness). The material comprises gravel (10%–50%), silt and clay (28%–45%), and sand (10%–50%). Material is generally thinner along ridges and thicker along concave backslopes and toe-slopes. Active channels and drainages contain localized deposits of Recent Alluvium (Qal) and Old Alluvium (Qoa). Qal deposits are located adjacent to active channels reaches thicknesses of 6 to 35 feet (within the Near West footprint) and comprises uncemented, loose to dense sand (25%–80%) and gravel (10%–55%), silt and clay (2%–40%), and trace boulders (up to 24-inch diameter). Qoa deposits are located along the margins of active channels and include partially cemented to well-cemented gravel (40%–60%), sand (25%–40%), silt and clay (18%–30%), with some cobbles and boulders (up to 24-inch diameter). Carbonate cementation varies by deposit age. Old Lacustrine (Qoa-Lu) units occur in limited areas as 1- to 4-foot-thick deposits overlying Gila sandstone, and include gravel <10%, clay and silt (37%–78%), and sand (20%–28%).	Arizona Upland Sonoran Desertscrub	No information available	5,274	54
		485 (GTES)	QUTU2	The majority of areas are covered by Qs deposits (along ridges and hillslopes) with some of Qal and Qoa deposits (adjacent to active channels).* See unit descriptions above.	Interior Chaparral	No information available	1,457	15

continued

Table 3.3.3-2. Predominant soils by alternative *(cont'd)*

Alternative	Total Acres	Map Unit Symbol (data source)	Map Unit Name	Map Unit Description and Soil Composition	Productivity† (pounds of biomass per acre or dominant vegetation community)	Fertility‡	Acreage within Map Unit	Percentage of Alternative
Alternative 3 – Near West – Ultrathickened	10,033	214 (GTES)	CEMI2, LATR	Similar to Alternative 2 Near West Proposed Action (see above)	Arizona Upland Sonoran Desertscrub	No information available	5,274	54
		485 (GTES)	QUTU2	Similar to Alternative 2 Near West Proposed Action (see above)	Interior Chaparral	No information available	1,457	15
Alternative 4 – Silver King	10,861	214 (GTES)	CEMI2, LATR	No direct observations from Klohn Crippen Berger Ltd. (2017) were available to inform interpretations regarding soils or quaternary deposit thickness.* Based on extrapolation (from aerial imagery and geological mapping), most canyon bottoms are likely to contain Qal and Qoa deposits (adjacent to active channels) with some Qs deposits along ridges and hillslopes. See unit descriptions above, in this table.	Arizona Upland Sonoran Desertscrub	No information available	1,259	12
		303 (GTES)	FOSP2, QUTU2, GRANITE OUTCROP	No direct observations from Klohn Crippen Berger Ltd. (2017) were available to inform interpretations regarding soils or quaternary deposit thickness.* Based on extrapolation (from aerial imagery and geological mapping), most areas are covered by Qs deposits (along ridges and hillslopes) with some Qal and Qoa deposits (adjacent to active channels). See unit descriptions above, in this table.	Mix of Semi-desert Grassland and Lower Colorado River Sonoran Desertscrub	No information available	5,345	50
		485 (GTES)	QUTU2	No direct observations from Klohn Crippen Berger Ltd. (2017) were available to inform interpretations regarding soils or quaternary deposit thickness.* Based on extrapolation (from aerial imagery and geological mapping), most areas are covered by Qs deposits (along ridges and hillslopes) with some discrete Qal and Qoa deposits (adjacent to active channels). See unit descriptions above, in this table.	Interior Chaparral	No information available	1,457	14

continued

Table 3.3.3-2. Predominant soils by alternative *(cont'd)*

Alternative	Total Acres	Map Unit Symbol (data source)	Map Unit Name	Map Unit Description and Soil Composition	Productivity† (pounds of biomass per acre or dominant vegetation community)	Fertility‡	Acreage within Map Unit	Percentage of Alternative
Alternative 5 – Peg Leg East Option	17,153	74 (SSURGO)	Pantano-Anklam-Rock outcrop complex, 3 to 20 percent slopes	The Pantano soil series are well-drained soils formed on steep alluvial and colluvial slopes and have a loamy matrix with ≥ 35% rock fragments. Soils are shallow, overlying fractured bedrock at 20-inch depths. The Anklam soil series are well-drained soils formed on moderate to steep alluvial slopes and have a loamy matrix with ≥ 35% rock fragments. Soils are shallow, overlying fractured bedrock at 10- to 20-inch depths. Granite or other bedrock outcrops cover 20% of the soil surface.	Pantano: 350 lb/acre Anklam: 500 lb/acre Bedrock: negligible	Organic Matter: 0.5%–1% pH: 6.1–8.4	4,243	25
		98 (SSURGO)	Tubac-Rillino complex, 3 to 25 percent slopes	The Tubac soil series are well-drained soils formed along alluvial fan terraces and basin floors with 0%–8% slopes. Soil textures are fine clay to sandy clay loam with 2% rock fragments, with diagnostic argillic horizons from 11–44 inches. Soils reach depths of 44–60+ inches. The Rillino soil series are well-drained soils formed along alluvial fan terraces with 1%–50% slopes. Soil textures range from sandy loam to loam with 15%–35% rock fragments. Soils reach depths of 60+ inches, with calcic (calcium carbonate-rich) soils at a depth of 5–20 inches.	Tubac: 600 lb/ac Rillino: 400 lb/ac	Organic Matter: 1%	4,210	25

continued

Table 3.3.3-2. Predominant soils by alternative *(cont'd)*

Alternative	Total Acres	Map Unit Symbol (data source)	Map Unit Name	Map Unit Description and Soil Composition	Productivity† (pounds of biomass per acre or dominant vegetation community)	Fertility‡	Acreage within Map Unit	Percentage of Alternative
Alternative 5 – Peg Leg West Option	17,530	74 (SSURGO)	Pantano-Anklam-Rock outcrop complex, 3 to 20 percent slopes	Same as Alternative 5 Peg Leg East Option (above)	Pantano: 350 lb/acre Anklam: 500 lb/acre Bedrock: negligible	Organic Matter: 0.5%–1% pH: 6.1–8.4	4,381	25
		98 (SSURGO)	Tubac-Rillino complex, 3 to 25 percent slopes	Same as Alternative 5 Peg Leg East Option (above)	Tubac: 600 lb/acre Rillino: 400 lb/acre	Organic Matter: 1% pH: 6.6–8.4	4,226	25
Alternative 6 – Skunk Camp North Option	16,116	485 (GTES)	QUTU2	No direct observations from (Klohn Crippen Berger Ltd. 2017) were available to inform interpretations regarding soils or quaternary deposit thickness.* Based on extrapolation (from aerial imagery and geological mapping), most areas are covered by Qs deposits (along ridges and hillslopes) with some discrete Qal and Qoa deposits (adjacent to active channels). See unit descriptions above, in this table.	Interior Chaparral	No information available	1,856	12
		104 (SSURGO)	White House-Stronghold complex, 5 to 60 percent slopes	The White House soil series are well-drained soils formed in alluvial fans, with 0%–60% slopes. Soil textures range from sandy clay to clay with less than 35% rock fragments. Soils reach depths of 60+ inches, with argillic horizons from 3–39 inches. The Stronghold soil series are well-drained soils formed in alluvial fan remnants, with 1%–60% slopes. Soil textures range from loamy sand to loam with less than 35% rock fragments. Soils reach depths of 60+ inches, with a calcic (calcium carbonate–rich) horizon from 1–60 inches.	White House: 800 lb/acre Stronghold: 600 lb/acre	Organic Matter: >1% pH: 5.6–8.4	6,429	41

continued

Table 3.3.3-2. Predominant soils by alternative *(cont'd)*

Alternative	Total Acres	Map Unit Symbol (data source)	Map Unit Name	Map Unit Description and Soil Composition	Productivity† (pounds of biomass per acre or dominant vegetation community)	Fertility‡	Acreage within Map Unit	Percentage of Alternative
Alternative 6 – Skunk Camp South Option	16,557	485 (GTES)	QUTU2	Same as Alternative 6 Skunk Camp North Option (above)	Interior Chaparral	No information available	1,739	11
		104 (SSURGO)	White House-Stronghold complex, 5 to 60 percent slopes	Same as Alternative 6 Skunk Camp North Option (above)	White House: 800 lb/acre Stronghold: 600 lb/acre	Organic Matter: >1% pH: 5.6–8.4	6,429	40

* Soil composition data within Tonto National Forest lands are derived from the Near West Tailings Storage Facility Geotechnical Site Characterization Report (Klohn Crippen Berger Ltd. 2017). Data were specific to the Near West tailings storage facility but have been extrapolated (as appropriate) to other alternatives.

† Productivity data are reported as pounds of biomass per acre per year, as derived from SSURGO datasets where data are available (Natural Resources Conservation Service 2017). No productivity data are available for areas mapped by GTES data; dominant vegetation communities (as reported in table 3.3.3-3) are used as a proxy for productivity.

‡ Limited soil fertility data are available from SSURGO datasets (Natural Resources Conservation Service 2017). No soil fertility data are available for areas mapped by GTES data (U.S. Forest Service 2018e).

Desert Ecosystems (includes Arizona Upland Sonoran Desertscrub and Lower Colorado River Sonoran Desertscrub)

This vegetation community generally dominates in broad valleys, lower bajadas, plains and low hills of lower elevations. Trees are sparse and the understory is bare ground or sparse grass and shrubs, typically whitethorn, creosote, and bursage. Cacti are also present, such as saguaro, prickly pear, and cholla. Common trees are palo verde, catclaw acacia, mesquite, and ironwood. On slopes, plants are often distributed in patches around rock outcrops where suitable soil exists.

Semi-Desert Grasslands

Typically occurring roughly 3,000 to 5,000 feet in elevation, this vegetation community is dominated by diverse perennial grasses, which vary depending on region. Shrubs also occupy these grasslands, with predominant shrubs, including mesquite, snakeweed, creosote, and catclaw acacia.

Interior Chaparral

Typically occurring roughly 3,000 to 7,000 feet in elevation, this vegetation community consists of chaparral on side slopes that transition into pinyon-juniper woodlands. Chaparral is a term describing an ecosystem dominated by desert shrubs, grasses, and scrub oak. Interior chaparral has an open canopy and open space either bare or covered with grasses and forbs.

Table 3.3.3-3. Vegetation communities and land cover types in the analysis area

Vegetation Community or Landform Type	Alternatives 2 and 3 (acres)	Alternative 4 (acres)	Alternative 5 West Pipeline Option (acres)	Alternative 5 East Pipeline Option (acres)	Alternative 6 South Pipeline Option (acres)	Alternative 6 North Pipeline Option (acres)
Human dominated	5,511	5,511	5,620	5,547	5,123	5,511
Interior Chaparral	10,138	12,385	10,137	10,410	17,790	20,061
Lower Colorado River Sonoran Desertscrub	17,075	20,934	19,521	21,627	19,396	20,498
Mesquite	5	5	6	5	15	15
Open-Pit Mine	3	3	3	3	3	3
Pine-Oak	185	362	185	185	439	500
Pinyon-Juniper	760	1,109	1,166	1,640	1,604	1,362
Riparian	1,336	1,316	1,771	1,854	1,542	1,472
Rock	102	103	102	102	108	117
Semidesert Grassland	1,855	6,384	1,465	2,021	18,831	25,459
Arizona Upland Sonoran Desertscrub	45,110	37,250	96,987	83,365	39,982	36,886
Water	29	29	29	29	15	29
Xeric Riparian	851	1021	1,611	1,526	2,065	2,618
Total Acres	**82,960**	**86,412**	**138,603**	**128,314**	**106,913**	**114,531**

Note: Acreages in this table are rounded to the nearest whole number

Pinyon-Juniper Woodland

Typically occurring roughly 4,500 to 7,000 feet in elevation, these woodlands occur on warm, dry sites on mountain slopes, mesas, plateaus, and ridges, and are characterized by being an open forest dominated by low, bushy, evergreen junipers and pinyon pines. Annual and perennial grasses, forbs, and shrubs typically abound beneath the woodland overstories.

Ponderosa Pine-Evergreen Oak

Typically occurring roughly 5,000 to 7,500 feet in elevation, these woodlands occur on mountains and plateaus generally south of the Mogollon Rim. Ponderosa pine intermingled with oak species predominate, mingled with patchy shrublands or grasslands.

Xeric Riparian

Xeric riparian or xeroriparian vegetation typically occurs along washes or arroyos that receive concentrated runoff during storms. Although often dry, the intermittent flows in these washes greatly affect the vegetation by providing additional periodic soil moisture. Channels are often clear of vegetation, but shrubs and small trees are located along the banks, such as acacia, mesquite, palo verde, and desert broom. Xeroriparian vegetation can vary from sparse to thick, depending on the amount of moisture received.

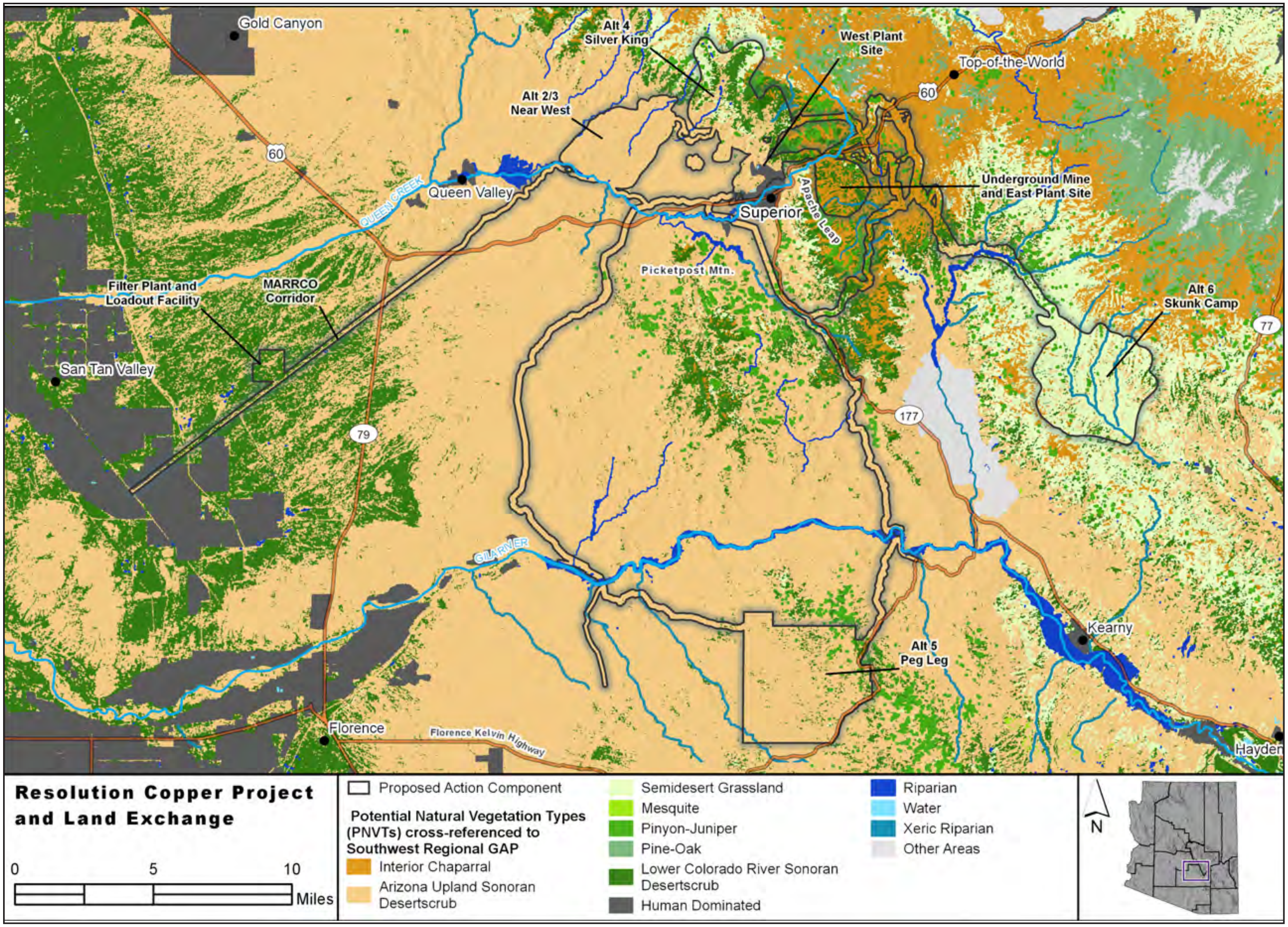


Figure 3.3.3-2. Vegetation communities and land cover types

Riparian

Riparian corridors are located along medium to large perennial streams in canyons and desert valleys, supported by the presence of persistent groundwater. Dominant trees can include willow, cottonwood, mesquite, ash, walnut, and sycamore. Understory is usually present, including herbaceous vegetation, grasses, and wetland species along streambanks. Note that a full discussion of all areas determined to be dependent on groundwater is included in section 3.7.1, including potential impacts caused by mine dewatering.

SPECIAL STATUS PLANT SPECIES

Special status plant species addressed include species listed under the Endangered Species Act (ESA) for Gila and Pinal Counties, Tonto National Forest Sensitive Plant Species, as well as BLM Sensitive Plant species for the BLM Tucson Field Office. See Newell (2018g) for a complete list of all species addressed and their potential for occurrence.

Special status plant species with the potential to occur in the analysis area are broken out by action alternative in table 3.3.3-4, including information on their habitat components and geographic ranges. Figure 3.3.3-3 depicts the designated critical habitat for ESA-listed plant species in and near the analysis area. The only special status plant species critical habitat present is for acuña cactus, which occurs in the project area for Alternative 5 for both the east and west pipeline options.

Baseline data of species-specific surveys for special status plants species included sample surveys of portions of some of the alternatives for four species: Arizona hedgehog cactus (*Echinocereus triglochidiatus var. arizonicus*), mapleleaf false snapdragon *(Mabrya [Maurandya] acerifolia*), Hohokam agave (*Agave murphey*i), and Parish's Indian mallow (*Abutilon parishii*). For Arizona hedgehog cactus, survey data from WestLand Resources Inc., Tonto National Forest, and SWCA Environmental Consultants were used for this analysis. These surveys encompassed approximately 4,738 acres and covered most of the East Plant Site and subsidence area, as well as portions of the transmission corridor from Silver King to Oak Flat, Alternative 6 (both the south and north pipeline options), and Alternative 6 north and south transmission corridor. Approximately 98 individual Arizona hedgehog cacti were located during these surveys. For mapleleaf false snapdragon, 336 acres of suitable habitat was surveyed, and none were detected. For Hohokam agave, 239 acres of suitable habitat was surveyed, and none were detected. For Parish's Indian mallow, 949 acres of suitable habitat was surveyed and approximately 90 plants were observed on and around the bluffs in the area just west of Perlite Spring in the northeastern portion of the proposed tailings facility of Alternatives 2 and 3. Some of the observed plants were outside the random sample survey area as well. Additionally, approximately 40 Parish's Indian mallow plants were also detected during survey in the area south of Roblas Canyon in the northwestern portion of the proposed tailings facility of Alternatives 2 and 3 (WestLand Resources Inc. 2017a).

Note that where specific data on the presence of special status plant species are shown to be lacking, several mitigations are required that would provide for collection of this information (see section 3.3.4.9).

ARIZONA NATIVE PLANT LAW SPECIES

Numerous native plant species are protected from destruction under the Arizona Native Plant Law (Title 3 Arizona Administrative Code Chapter 3); the law also encourages salvage of these species. The Arizona Department of Agriculture enforces the Arizona Native Plant Law (Arizona Department of Agriculture 2019). Within the four given categories—Highly Safeguarded, Salvage Restricted, Salvaged Assessed, and Harvest Restricted—most are common species except for within the Highly Safeguarded category, which includes rare species. Thus, most species designated as Highly Safeguarded are also ESA endangered or threatened species or sensitive species under other land management agency policies. Therefore, those species that are identified in this analysis as protected under the Arizona Native Plant Law are addressed under more stringent regulations; a separate analysis for Arizona Native Plant Law species is not considered necessary for any of the action alternatives.

Table 3.3.3-4. Special status plant species with the potential to occur in the analysis area

Common Name (Scientific Name)	Status	Habitat	Alternatives 2 and 3	Alternative 4	Alternative 5	Alternative 6
Acuña cactus (*Echinomastus erectocentrus* var. *acunensis*)	ESA: E with critical habitat. Found in Maricopa, Pinal, and Pima Counties	Occurs in valleys and on small knolls and gravel ridges of up to 30 percent slope in the Palo Verde-Saguaro Association of the Arizona Upland subdivision of the Sonoran Desertscrub. Elevation between 1,198 and 3,773 feet amsl (U.S. Fish and Wildlife Service 2016a).	Unlikely to occur.	Unlikely to occur.	Possible to occur where small knolls and gravel ridges of up to 30 percent slope are present near the tailings facility and along pipeline corridor routes. Critical habitat for the species is located along the west pipeline option and fencing area, adjacent to the tailings facility, and along the fence line for the east pipeline option.	Unlikely to occur.
Arizona hedgehog cactus (*Echinocereus triglochidiatus* var. *arizonicus*)	ESA: E No critical habitat. Found in Maricopa, Pinal, and Gila Counties.	Found on dacite or granite bedrock, open slopes, in narrow cracks, between boulders, and in the understory of shrubs in the ecotone between Madrean Evergreen Woodland and Interior Chaparral. Elevation between 3,300 and 5,700 feet amsl (Tonto National Forest 2000).	Known to occur, where soils of igneous origin (primarily Shultze granite and dacite) are present on the East Plant Site and subsidence area.	Known to occur at the East Plant Site and in subsidence area. Possible to occur in tailings facility area.	Known to occur at the East Plant Site and in subsidence area.	Known to occur at the East Plant Site and in subsidence area. Possible to occur along pipeline route alternatives and in tailings facility location.
Chiricahua Mountain alumroot (*Heuchera glomerulata*)	Tonto National Forest: S	Found on north-facing shaded rocky slopes, near seeps, springs, and riparian areas, often in humus soil. Elevation between 4,000 and 9,000 feet amsl (Tonto National Forest 2000).	Unlikely to occur.	Possible to occur in tailings facility area.	Unlikely to occur.	Possible to occur.

continued

Table 3.3.3-4. Special status plant species with the potential to occur in the analysis area *(cont'd)*

Common Name (Scientific Name)	Status	Habitat	Alternatives 2 and 3	Alternative 4	Alternative 5	Alternative 6
Mapleleaf false snapdragon (*Mabrya [Maurandya] acerifolia*)	Tonto National Forest: S	Occurs on rock overhangs and in bare rock/talus/scree, cliff, and desert habitats. Elevation around 2,000 feet amsl (Tonto National Forest 2000).	Possible to occur at tailings facility and borrow sites.	Unlikely to occur.	Unlikely to occur.	Possible to occur.
Parish's Indian mallow (*Abutilon parishii*)	Tonto National Forest: S BLM: S	Occurs in mesic situations in full sun within higher elevation Sonoran desertscrub, desert grassland, and Sonoran deciduous riparian forest. Elevation between 3,000 and 4,800 feet amsl (Tonto National Forest 2000).	Known to occur at tailings facility. Possible to occur at the West Plant Site, borrow sites, and in the MARRCO corridor.	Possible to occur at the West Plant Site, borrow sites, tailings facility area, and in the MARRCO corridor.	Possible to occur at the West Plant Site, borrow sites, and in the MARRCO corridor.	Possible to occur at the West Plant Site, borrow sites, and in the MARRCO corridor.
Pringle's fleabane (*Erigeron pringlei*)	Tonto National Forest:	Ledges of cliffs and rock crevices in canyons, near springs and in shaded canyons. Elevation between 3,500 and 7,000 feet amsl (Tonto National Forest 2000).	Possible to occur where soils of igneous and metamorphic granites are present.	Unlikely to occur.	Unlikely to occur.	Possible to occur.

Note: The analysis area for each alternative includes all project components (i.e., West Plant Site, East Plant Site, tailings storage facility, etc.).

Status Definitions

Tonto National Forest:

S = Sensitive. Species identified by a Regional Forester for which population viability is a concern, as evidenced by a significant current or predicted downward trends in population number or density or significant current or predicted downward trends in habitat capability that would reduce a species' existing distribution.

Endangered Species Act (ESA):

E = Endangered. Endangered species are those in imminent jeopardy of extinction. The ESA specifically prohibits the take of a species listed as endangered. Take is defined by the ESA as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to engage in any such conduct.

Bureau of Land Management (BLM):

S = Sensitive. Species that could easily become endangered or extinct in the state.

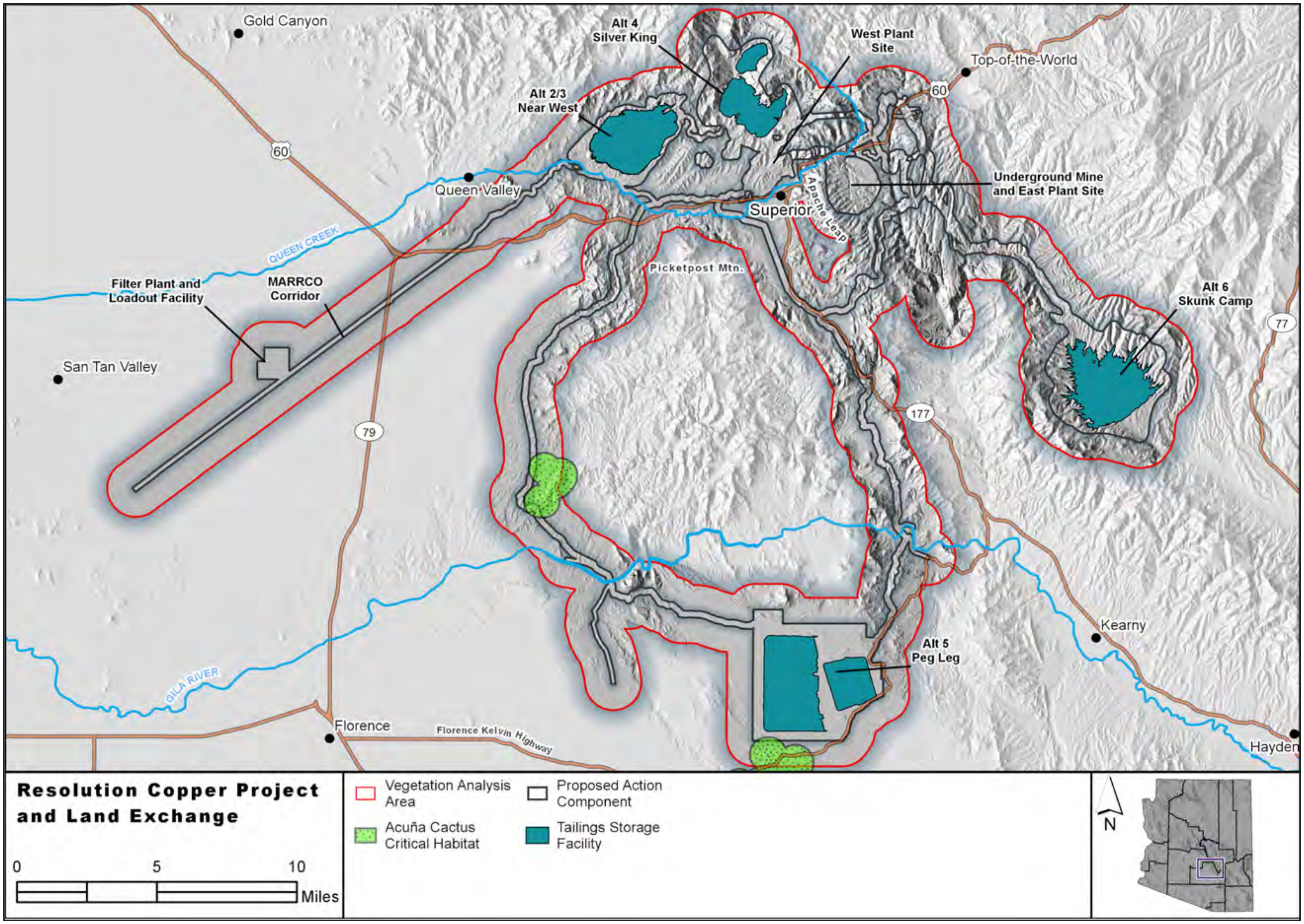


Figure 3.3.3-3. Designated and proposed critical habitat for ESA-listed plant species

NOXIOUS AND INVASIVE WEEDS (INCLUDING FEDERAL, STATE, AND TONTO NATIONAL FOREST LISTS)

Eighty-nine Federal, Tonto National Forest, and Arizona Department of Agriculture noxious and invasive weed species were evaluated for this analysis. There was overlap between the different species lists, and species numbers do not double-count species. See Newell (2018g) for a table of species and their status listings. Of those listed noxious and invasive weed species, Alternatives 2 and 3 have 33 species known to occur or possible to occur within the analysis area; Alternative 4 has 38 species known to occur or possible to occur within the analysis area; Alternative 5 has 26 species known to occur or possible to occur within the analysis area; and Alternative 6 has 31 species possible to occur within the analysis area.

Existing Disturbance within Mine Area and Selected Lands

A variety of land use disturbances have affected the condition of vegetation and soils within and near the project area footprint. Historical and ongoing mining and mineral exploration, land development, grazing, recreation, and fires have left a legacy of disturbances to the landscape (table 3.3.3-5). Total acreage of each disturbance type within the project footprint varied by alternative. Most alternatives had approximately 1,300 to 1,400 acres of previous disturbance, with the exception of Alternative 4, which had 2,719 acres of previous disturbance (which included 1,528 acres of fire disturbance). More information regarding the nature and extent of disturbance is provided in Newell (2018g).

Existing Vegetation and Soil Trends

Relatively little long-term monitoring and evaluation of soil and vegetation health exists for the analysis area. Most of the monitoring available has been undertaken for assessment for rangeland health and livestock grazing suitability (see section 3.16 for discussion of livestock grazing).

Table 3.3.3-5. Existing disturbance acreage by alternative (calculated within the project footprint)

Alternative	Facilities Disturbance (acreage)	Road Disturbance* (acreage)	Fire Disturbance (acreage)	Total Disturbance (acreage)
Alternative 2 – Near West Proposed Action	1,086	122	61	1,270
Alternative 3 – Near West – Ultrathickened	1,086	122	61	1,270
Alternative 4 – Silver King	1,084	107	1,528	2,719
Alternative 5 – Peg Leg West Option	1,100	98	77	1,274
Alternative 5 – Peg Leg East Option	1,100	88	62	1,250
Alternative 6 – Skunk Camp North Option	1,086	131	192	1,409
Alternative 6 – Skunk Camp South Option	1,100	151	134	1,385

* Single-track recreational trails excluded from area calculations.

Long-term monitoring of soil and vegetation conditions was conducted on the Millsite grazing allotment, managed by the Forest Service, which includes the area of the Alternative 2 and 3 tailings storage facility. Range monitoring has been conducted in this area from 1956 through 2003. The most recent trends between 1991 and 2003 indicate that the overall state of vegetation is in very poor to poor condition, with largely downward trends. Soils are similar, rated mostly poor condition, but with a stable trend (U.S. Forest Service 2010d). These trends in vegetation and soil conditions are likely the result of historic-era grazing and other disturbances (U.S. Forest Service 2010d).

Some additional rangeland health assessments have been conducted for the Teacup Allotment, managed by the BLM, which includes the area of the Alternative 5 tailings storage facility. In 2013, it was observed that overall the soil on the allotment was stable, and the allotment exhibited biotic integrity and was in a productive and sustainable condition (Bureau of Land Management 2017a).

3.3.4 Environmental Consequences of Implementation of the Proposed Mine Plan and Alternatives

3.3.4.1 Alternative 1 – No Action Alternative

Under the no action alternative, the proposed project would not be constructed and potential impacts on soils, vegetation communities, special status plant species, and noxious weeds would not occur. Impacts on soil and vegetation resources from existing disturbances (e.g., recreation, livestock grazing, mining and development, wildfires) would continue.

3.3.4.2 Impacts Common to All Action Alternatives

The proposed project would include three phases: construction, operations, and closure/reclamation. All phases have the potential to affect (1) soil resources, (2) revegetation potential, (3) vegetation communities, (4) special status plant species, and (5) noxious weeds, as detailed in the following text.

Effects of the Land Exchange

The selected Oak Flat Federal Parcel would leave Forest Service jurisdiction. The role of the Tonto National Forest under its primary authorities in the Organic Administration Act, Locatable Regulations (36 CFR 228 Subpart A), and Multiple-Use Mining Act is to ensure that mining activities minimize adverse environmental effects on National Forest System surface resources; this includes effects on the soil and vegetation that occur on the Oak Flat Federal Parcel. The removal of the Oak Flat Federal Parcel from Forest Service jurisdiction negates the ability of the Tonto National Forest to regulate effects on these resources, or manage them to achieve desired conditions, including for control of noxious and invasive weeds.

The offered parcels would come under Federal jurisdiction. Specific management of the soil and vegetation resources of those parcels would be determined by the agencies to meet desired conditions or support appropriate land uses. In general, these parcels contain a variety of ecosystems similar to those found in the analysis area, including riparian, xeroriparian, semi-desert grassland, and desert ecosystems, that would come under Federal jurisdiction.

Effects of Forest Plan Amendment

The Tonto National Forest Land and Resource Management Plan (1985b) provides guidance for management of lands and activities within the Tonto National Forest. It accomplishes this by establishing a mission, goals, objectives, and standards and guidelines. Missions, goals, and objectives are applicable on a forest-wide basis. Standards and guidelines are either applicable on a forest-wide basis or by specific management area.

A review of all components of the 1985 Forest Plan was conducted to identify the need for amendment due to the effects of the project, including both the land exchange and the proposed mine plan (Shin 2019). A number of standards and guidelines (15 for soil, 33 for vegetation) were identified applicable to management of ecosystems and vegetation communities. None of these standards and guidelines were found to require amendment to the proposed project, either on a forest-wide or management area-specific basis. For additional details on specific rationale, see Shin (2019).

Summary of Applicant-Committed Environmental Protection Measures

A number of environmental protection measures are incorporated into the design of the project that would act to reduce potential impacts on soils and vegetation. These are non-discretionary measures, as they are currently part of the GPO, and their effects are accounted for in the analysis of environmental consequences.

From the GPO (Resolution Copper 2016d), Section 4.5, "Water Resources," Resolution Copper has outlined a variety of measures to reduce impacts on soils:

- Road embankment slopes will be graded and stabilized with vegetation or rock as practicable to prevent erosion;
- During construction and operations, diversions will be constructed around the affected areas to minimize erosion. A number of best management practices, including check dams, dispersion terraces, and filter fences, also will be used during construction and operations; and
- Off-road vehicle travel across Tonto National Forest will generally be avoided.

Resolution Copper has also developed a noxious weed plan (Resolution Copper 2019) to reduce impacts on vegetation:

- Newly reclaimed areas on Tonto National Forest will be monitored for weeds and invasive plants for the first 5 years after reclamation. Infestations of invasive species would be treated as soon as they are identified, or as soon as weather conditions are appropriate for treatment.
- Additionally, in the "Baseline EA Decision Notice," Resolution Copper stipulated that on NFS lands, seed mixes used in reclamation will be certified free of seeds listed on the Forest Service's noxious weed list and contain only species native to the project area. Seed mixes will be developed from a native species seed list approved by the Forest Service.

Desired Future Conditions

Desired future conditions were informed by internal work by the Tonto National Forest on the revised forest plan. These desired conditions are based on Ecological Response Units (ERUs), which are mapped ecosystem types that represent the range of conditions that occur under natural disturbance regimes. The desired future conditions of ERUs that occur in the analysis area are described here by ERU. The distribution and condition of these ERUs are strongly tied to the health of soils, climate, topography, and other environmental factors.

DESERT ECOSYSTEMS

The Desert Ecosystems ERU in the analysis area includes the Lower Colorado River Sonoran Desertscrub and Arizona Upland Sonoran Desertscrub, the desired future conditions of which include the following:

- Vegetation community composition and structure should include the following: 10 to 25 percent perennial grass and cacti cover, presence of saguaro (*Carnegiea gigantea)* and mesquite *(Prosopis* sp.*)* that provide habitat for cavity nesting birds, and limited infestation of non-native grasses (ideally less than 1 percent cover) to mitigate for fine-fuel potential to increase fire susceptibility.
- Fires should be infrequent and localized with return intervals greater than 100 years.
- Suitable habitat for federally listed and rare or special status animal and plant species is preserved.

SEMI-DESERT GRASSLANDS

The Semi-Desert Grasslands ERU is limited to the semi-desert grasslands vegetation community, the desired future conditions of which include the following:

- Vegetation community composition and structure should include the following: a variety of cool- and warm-season understory plants, less than 10 percent tree and shrub canopy cover, and limited cover by non-native species.
- Native herbaceous vegetation cover provides fine fuels to support stand-replacement fires; however, non-native annual vegetation cover should be limited to mitigate the spread, intensity, and severity of uncharacteristic fire.
- Habitat is preserved to support wildlife.

INTERIOR CHAPARRAL

The desired future conditions for the Interior Chaparral ERU and vegetation community include the following:

- Vegetation community composition and structure should include the following: dense thickets of closed shrub canopy cover (40 percent cover on dry sites to 80 percent cover on wet sites) dominated by shrub live oak (*Quercus turbinell*a), thick shrub litter, annual regeneration of native grasses and forbs (in most years), and low cover by non-native annual species.
- Stand-replacing fires should occur at 35- to 100-year fire return intervals to support diverse community ages at the landscape scale; native fire-adapted species resprout vigorously after fire to prevent excessive erosion; and non-native annual vegetation cover is kept to a minimum to avoid uncharacteristic fire.
- Habitat is preserved to support wildlife.

PINYON-JUNIPER WOODLAND

The desired future conditions for the Pinyon-Juniper Woodland ERU and vegetation community include the following:

- Vegetation community composition should include the following: even-aged patches (tens to hundreds of acres) of pinyon and juniper trees forming multi-aged woodlands (including trees greater than 300 years old), closed canopy cover by trees to shade ground surfaces, structural diversity from old trees, snags, woody debris, and sparse ground cover (5 to 15 percent) of shrubs, perennial grasses, and forbs.
- Shrubs and herbaceous ground cover is sparse, supporting low-intensity ground fires.
- Habitat is preserved to support wildlife.

PONDEROSA PINE-EVERGREEN OAK

The Ponderosa Pine-Evergreen Woodland ERU includes the pine-oak vegetation community, the desired future conditions of which include the following:

- Vegetation community composition should include the following: open forest stands with diverse tree ages, sizes, and densities (at the landscape scale), some old-growth tree stands, shrub and herbaceous basal cover ranging from 5 to 15 percent.
- The landscape is a functioning ecosystem that contains all its components, processes, cycles, and conditions that result from natural disturbances (e.g., insects, diseases, fire, and wind) and as supported through human disturbance. The composition, structure, and function of vegetative conditions are resilient to the frequency, extent, and severity of disturbances and climate variability.
- Habitat is preserved to support wildlife.

XERIC RIPARIAN

The desired future conditions for Xeric Riparian ERUs include the following:

- Vegetation community composition should include xeric riparian/riparian scrubland and upland species, upland desert scrub species intergrading within riparian scrubland (reaching higher densities at drier sites), dominant shrubs reaching heights up to 10 feet, and species such as arrow-weed, burro bush (*Ambrosia* sp.), and desert broom (*Baccharis sarothroides*) dominating sandy soils on secondary floodplains.
- Soil and other environmental conditions support a diversity of healthy, deciduous desert trees and scrub vegetation.
- Habitat is preserved to support wildlife.

RIPARIAN

The desired future conditions for Riparian ERUs include the following:

- Vegetation community composition would vary based on hydrologic conditions and may include the following: facultative- and obligate-wetland species; cottonwood-willow habitats; common distributions of hackberry (*Celtis reticulata*) and mesquite, velvet ash (*Fraxinus velutina*) and Arizona sycamore (*Platanus wrighti*i) at mid- to high elevations; blue paloverde (*Parkinsonia florida*) and catclaw acacia (*Senegalia greggii*), and ironwood (*Olneya tesota*) at warmer low-elevation sites; well-established mesquite stands are located in abandoned channels or terraces, connecting riparian vegetation and the uplands to support wildlife movement; and understories with open to closed conditions, including woody species and herbaceous vegetation cover that support bank stability. Healthy riparian vegetation communities show few signs of stress, wilting, or disease; high reproductive output; and minimal soil compaction/degradation.
- Flood timing, magnitude, and frequency maintain conditions for vernal flood-adapted species, such as Gooding's willow (*Salix gooddingii*) and cottonwood (*Populus* spp.)-willow (*Salix* spp.).
- Wildfire frequency and intensity with the adjacent uplands (riparian corridor) is low, thereby reducing flooding or erosional risk to riparian areas.
- Habitat is preserved to support wildlife.

Reclamation Plans and Effectiveness

CONCEPTUAL RECLAMATION PLANS

General Reclamation Goals and Strategies

Reclamation plans are required under several regulatory programs, including by the Forest Service as part of a final mining plan of operations, by ADEQ as part of the Aquifer Protection Permit program, and by the Arizona State Mine Inspector. The primary goals of reclamation are to stabilize areas of surface disturbance, prepare areas for post-mining land use, and ensure long-term protection of the surrounding land, water, and air. Reclamation and closure standards are established by these programs that must be met by the company, and financial assurance or bonding is required to ensure the capability exists to conduct and complete reclamation activities.

The following discussion is based on the conceptual reclamation plans that have been prepared to date by Resolution Copper and are included in the GPO. Note that a mitigation measure is required that would provide for preparation of detailed reclamation plans, specific to the preferred alternative and supported by site-specific data collection, that would provide more extensive information than that produced to date (see section 3.3.4.9).

Key tenets guiding the Resolution Copper reclamation plans are implementing reclamation as soon as practicable (including concurrent reclamation while the mine is still operational, where feasible), return disturbed areas to near-natural conditions, salvage soil resources (where

practicable) for later use in reclamation, and monitor to ensure that reclamation is successful and reclamation and closure standards are met.

The general reclamation steps identified by Resolution Copper in the GPO (see section 6 in Resolution Copper (2016d)) are as follows:

- Decommission facilities (remove equipment, chemicals, furnishings)
- Demolish or dismantle structures and buildings, including pipelines, storage tanks, and power lines. This includes removing foundations up to 3 feet below grade. Some facilities like pipelines, wells, or power lines may be transferred to third parties for continued use where beneficial.
- Recontour and regrade disturbed areas, including roads not needed for future uses. Many stormwater controls (diversion ditches, seepage collection ponds) need to stay in place permanently or for decades after closure of the mine to control water quality (analyzed in detail in section 3.7.2).
- Replace growth media, using salvaged soils or borrow soils (largely Gila Conglomerate)
- Seeding or planting
- Monitoring and maintenance

Tailings Reclamation Plans

The largest area of disturbance from the proposed project is from the tailings storage facility, and virtually all of the area taken up by the tailings can be reclaimed. Specific details for closure of the tailings storage facilities differ by alternative (Golder Associates Inc. 2018a; Klohn Crippen Berger Ltd. 2018a, 2018b, 2018c, 2018d, 2018e). In general, closure of the tailings storage facilities takes place in several phases:

- Final deposition of the tailings is managed so that the PAG tailings are ultimately covered with NPAG tailings to prevent contact with oxygen (not applicable to Alternative 4).
- At the same time, the recycled water pond is allowed to gradually shrink through evaporation or water use (not applicable to Alternative 4).
- Engineered seepage controls remain in place as long as monitoring indicates they are needed to protect downstream water quality. Seepage collection ponds would remain in place to collect seepage and stormwater. Until water quality is acceptable for release to the environment (this is typically determined by ADEQ through the APP program), the collected water is either pumped back to the recycled water pond while it exists, or the ponds are engineered to allow the water to evaporate once the recycled water pond is gone. Note that specific release criteria would be developed in detailed reclamation plans, which are a required mitigation by the Forest Service (see section 3.3.4.9).
- When surfaces are no longer going to be disturbed, growth media are placed on the surface and any treatments or additives are used. Generally, about 1.5 feet of growth media are planned for, but would vary across the surface, depending on needs. Rock armoring would be used in places where erosion is a concern on slopes or along stormwater conveyance channels. Seeding or planting would then take place on the growth media. Note that specific closure materials, depths, and preparations would be developed in detailed reclamation plans, which are a required mitigation by the Forest Service (see section 3.3.4.9).

Fully successful reclamation would either meet the desired conditions for the landscape or be sufficient to support the chosen post-mine land uses. A fully reclaimed tailings storage facility should be a stable landform (low risk of large slumps or collapses), have a stable surface either vegetated or armored (low risk of erosion from water or wind), have no long-term water quality concerns from runoff or seepage, and

be sustainable without active management. Long-term sustainability requires a balanced interaction of growth media, water, and vegetation. The growth media act to store moisture, which supports the vegetation, but are vulnerable and have to be protected from erosion during storm events. Vegetation helps anchor the growth media and slow runoff, allowing it to infiltrate into the soil. Post-closure monitoring and comparison to clear success criteria is the means to ensure the balance of growth media, water, and vegetation is functioning properly.

Expected Timing of Reclamation Activities

Decommissioning and demolishing structures and regrading/recontouring all take place during the 5-year closure period described in the GPO. For tailings, the closure periods are longer because they depend on management of the recycled water pond:

- Alternative 2. The slopes and tailings beaches are reclaimed in the first 5 years. It is estimated to take 25 years for the recycled water pond to be drawn down and reclaimed (Klohn Crippen Berger Ltd. 2018a). Active water management would continue as long as necessary. Note that specific release criteria would be developed in detailed reclamation plans, which are a required mitigation by the Forest Service (see section 3.3.4.9).
- Alternative 3. The slopes and tailings beaches, as well as the recycled water pond, are reclaimed in the first 9 years (Klohn Crippen Berger Ltd. 2018b). Active water management would continue as long as necessary.
- Alternative 4. The slopes and tailings piles are reclaimed in the first 5 years (Klohn Crippen Berger Ltd. 2018c). Active water management would continue as long as necessary.
- Alternative 5. The slopes and tailings piles are reclaimed in the first 5 years. An estimated 30 years is needed for water quality management, but would continue as long as necessary (Golder Associates Inc. 2018a).
- Alternative 6. Similar to Alternative 2, the slopes and tailings beaches are reclaimed in the first 5 years. It is estimated to take 25 years for the recycled water pond to be drawn down and reclaimed (Klohn Crippen Berger Ltd. 2018d). Active water management would continue as long as necessary.

EXPECTED EFFECTIVENESS OF RECLAMATION PLANS

As noted, the reclamation plans prepared to date by Resolution Copper and included in the GPO are conceptual in nature. The following discussion is based on the anticipated effectiveness of the conceptual plans. Note that a mitigation measure is required that would provide for preparation of detailed reclamation plans, specific to the Preferred Alternative and supported by site-specific data collection, that would provide more extensive information than that produced to date (see section 3.3.4.9), and would support detailed estimates of reclamation effectiveness to support post-closure financial assurance estimates.

A meta-analysis was completed to constrain the level of vegetation cover (and potential variability) that could be expected at a given time point after reclamation and revegetation efforts have commenced (see analysis details and source data in Bengtson (2019b)). The analysis included case studies from Arizona and New Mexico primarily from mining or mineral exploration activities, which reflect similar characteristics in vegetation communities, climate, soils, and disturbance types to the proposed project.[25]

Results of the meta-analysis are shown in figure 3.3.4-1. Each vertical bar in the figure represents the range in vegetation cover observed from a single year in a given case study. (Some case studies provided multiple years of data.) The combined results of all analyzed case

25. The meta-analysis is meant to capture the general potential for revegetation efforts to be successful but is not specific to the Resolution Copper Project. Limitations to consider in interpreting outcomes of the meta-analysis include the following: (1) variability in revegetation outcomes, (2) semi-quantitative nature of analysis, (3) sensitivity of outcomes to the degree of initial disturbance, and (4) lack of specificity of outcomes to any project components.

studies illustrate the range in observed vegetation cover (percentage of vegetation cover) that have been recorded previously. The analysis demonstrates the following relationships (from Arizona and New Mexico case studies), which would also be expected for Resolution Copper revegetation efforts:

- Vegetation cover (by native and non-native species) of 8 percent or greater is consistently established by mine year 10.
- Vegetation can be as low as 0 percent, as observed in year 1 for one case study or a high as 100 percent in mine year 4.5 in another case study, with significant variation among and within the years after reclamation.
- From the case studies illustrated in figure 3.3.4-1, vegetation cover may plateau around mine year 12; however, analysis of additional case studies is needed to confirm this trend.

Overall, these findings indicate that, irrespective of the revegetation and reclamation methods applied, a minimum of 8 percent of vegetation cover (including both native and non-native species) can consistently be established within project disturbance areas. While this level of vegetation growth would provide some soil cover and erosion control functions, it does not necessarily reflect the desired future conditions set forth by the Forest Service. The revegetation response is expected to be influenced by the nature of the surface disturbance, while irrigation or active soil management interventions could enhance revegetation success thereby reducing erosional losses and net negative impacts on soil productivity. More specific outcomes are discussed under "Closure and Reclamation Impacts" later in this section.

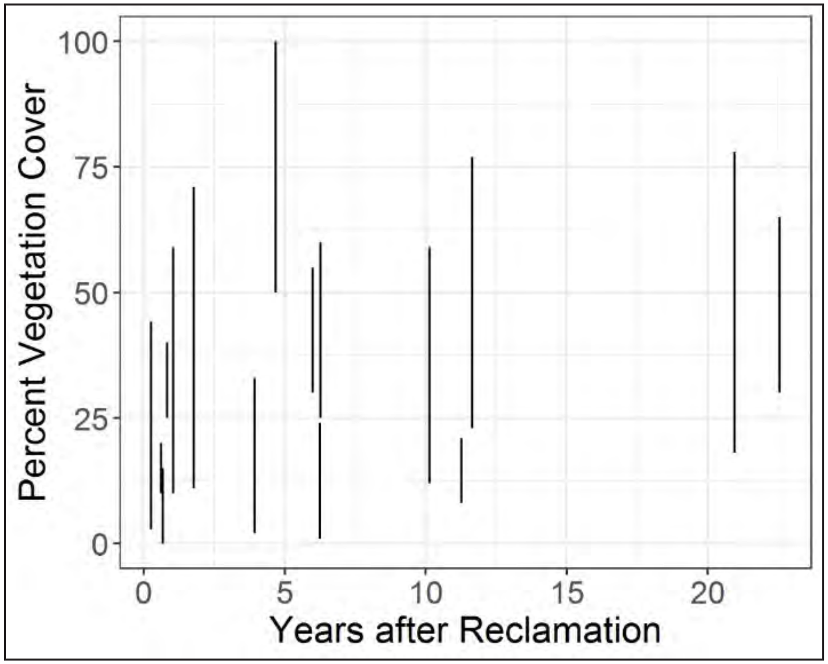


Figure 3.3.4-1. Meta-analysis summary. Each vertical bar represents the range in vegetation cover (percentage) observed from a single year (shown in years after reclamation) from a given case study. Data shown include only case studies from Arizona and New Mexico (see Bengtson (2019b)).

Construction/Operational Impacts

SOILS

Project ground-disturbing activities would potentially compact soils, accelerate erosion and soil loss, contaminate soils, and reduce soil productivity. The longevity of these impacts on soil productivity and

revegetation potential would depend on the nature of the disturbance and vary by project component and alternative. Most potential impacts on soil resources are common to all action alternatives; however, the level of impact is dependent on the nature of disturbance. For this analysis, the levels of impact, soil productivity responses, and revegetation success potential are summarized as six disturbance response groups, which are detailed in tables 3.3.4-1 and 3.3.4-2. Possible impacts include the following:

- Soils exposed by grading, excavation, subsidence, and vegetation clearing would be subject to accelerated wind and water erosion—all disturbances that decrease soil productivity. Erosion may also cause sediment losses and delivery to downstream washes and streams (see Section 3.7.2, Groundwater and Surface Water Quality).
- Topsoil mixing, compaction, removal, or redistribution may cause changes or losses to soil structure, seedbank, fertility, microbial communities, biotic soils, and water availability, which can negatively affect vegetation communities and further challenge revegetation efforts and success. Likewise, soil productivity and function would be lost for any soils that are not salvaged.
- Temporary loss of habitat while vegetation and soils recover from disturbance.
- Permanent soil productivity losses would occur where soils are covered, removed, or no longer available (i.e., covered by permanent structures or not reclaimed) to support vegetation or wildlife habitat. Tailings, waste-rock materials, exposed subsurface soils, or capping media used in reclamation may further challenge vegetation reestablishment.
- Waste materials may be a source of soil contamination (if not properly contained). Ground-disturbing activities could re-expose contaminated subsurface soils.

Soil salvage is one possible mitigation to erosional soil loss and productivity losses. While there are some advantages to storing soils, long-term soil stockpiling causes a number of biological and chemical changes requiring amelioration before soils are reapplied during reclamation (Strohmayer 1999). Specifically, long-term storage causes increases in soil bulk density, decreases in a soil's water holding capacity, changes to soil chemistry and nutrient cycling (e.g., development of anaerobic conditions, accumulation of ammonium, loss of organic carbon), losses of microbial community viability, and native soil seedbank losses (reviewed in (Strohmayer 1999)). In most arid ecosystems, the soil seedbank is limited to the upper 2 inches of soil (Scoles-Sciulla and DeFalco 2009); therefore, the process of salvaging even the upper 6 to 8 inches of soil can severely dilute seed concentrations (Abella et al. 2013). Moreover, seedbank viability has been shown to diminish by 68 percent over 2 years of stockpiling (Golos and Dixon 2014) and lose all germination potential within 5 years of storage (Scoles-Sciulla and DeFalco 2009).

A detailed analysis acreages of impacts on individual soil types is available in Newell (2018g).

VEGETATION COMMUNITIES, SPECIAL STATUS PLANT SPECIES, NOXIOUS WEEDS

Construction

All action alternatives would involve the removal of vegetation during construction activities, resulting in the direct loss of plant communities. Construction of tailings facilities for all alternatives would continue throughout most of mine life as areas would not be disturbed until necessary. The primary impacts on vegetation communities during construction of the action alternatives would be associated with

- removal and/or crushing of natural, native species;
- increased potential for noxious and invasive weed establishment and spread;
- decreased plant productivity from fugitive dust;

Table 3.3.4-1. Disturbance response groups

Disturbance Response Group	Disturbance Type and Description	Level and Type of Impact on Long-term Soil Productivity	Relative Revegetation Potential
No Disturbance	No disruption of soils or vegetation; e.g., areas within a facility remaining undisturbed	No impacts	Revegetation efforts are unneeded
Drive and Crush	Minimal disturbance from minor grading or vegetation mowing; surface soils and some vegetation remain intact; e.g., transmission line right-of-way	Minor impacts on soil productivity from compaction; some increased potential for erosion if vegetation is removed or soils are disrupted	High potential: Soil nutrients, cover, organic matter, microbiota, and seedbank remain intact, supporting revegetation success
Excavation with Soil Salvage	Soils are removed, salvaged, and replaced within disturbed surfaces; e.g., portions of the tailings storage facility	Moderate impacts on soil productivity due to topsoil redistribution; increased erosion potential, if revegetation is unsuccessful or delayed; potential for soil contamination in tailings or waste storage areas	Moderate potential: If salvaged soils are reapplied immediately, they will maintain some nutrients, organic matter, microbiota, and seedbank to enhance revegetation success
Excavation without Soil Salvage	Soils are removed or covered permanently, no soil salvage occurs, inert capping material used as plant growth medium; e.g., portions of the tailings storage facility	Major impacts on soil productivity due to loss of topsoils; increased erosion potential, if revegetation is unsuccessful or delayed; potential for soil contamination in tailings or waste storage areas	Low to moderate potential: Soil capping material lacks nutrients, organic matter, microbiota, and seedbank, limiting potential revegetation success
Subsidence Area	Soils and vegetation are redistributed as subsidence proceeds	Minor to moderate impacts on soil productivity, erosion potential, and existing vegetation depending on subsidence rates	Variable potential: No active revegetation planned; natural regeneration may occur as soil resources are redistributed
Structural Loss	Soils covered by a permanent structure	Soil productivity effectively lost in perpetuity; erosion losses are minimal under covered surfaces	Revegetation would not occur

Table 3.3.4-2. Disturbance, reclamation, and revegetation outcomes by facility and tailings alternative

Facility or Alternative	Facilities or Disturbance Remaining Post-decommissioning; Other Reclamation Considerations*	Primary (P) and Secondary (S) Disturbance Response Groups	Total Facility Disturbance (acres) and Impacts on Productivity†	High Water Erosion Potential (acres)‡	High Wind Erosion Potential (acres) ‡§
East Plant Site facility (all action alternatives)	Headframes and hoists for groundwater monitoring; paved or graveled roads necessary for monitoring; subsidence area; *contact water basins would be closed*	P: Subsidence Area S: Excavation without soil salvage; Structural loss; No disturbance	1,856	206	0
West Plant Site facility (all action alternatives)	Roads necessary to support the reclamation and closure; stormwater diversion infrastructure; *process water ponds and contact water basins would be closed*	P: Excavation with and without soil salvage S: Structural loss; No disturbance	940‡	153§	0
Filter plant and loadout facility and MARRCO corridor (all action alternatives)	Other MARRCO corridor or bridge infrastructure may remain (depending on other intended uses); *all tanks and ponds would be closed*	P: Excavation with and without soil salvage; Drive and crush S: Structural loss; No disturbance	1,248	939	0
Power transmission facilities (common to all action alternatives)	Power transmission facilities (e.g., electrical substations, transmission lines, power centers) to remain if post-mining use is identified	P: Drive and crush; Excavation with and without soil salvage S: Structural loss; No disturbance	670¶	274	0
Near West Proposed Action tailings storage facility (Alternative 2)	Roads and berms necessary to support the reclamation and closure; *concurrent reclamation of outer slopes; gradual reduction and closure of seepage ponds; 1.5-foot-thick rock armor (growth medium) shell on tailings*	P: Excavation with and without soil salvage S: Structural loss; No disturbance	5,084 (10,033)	4	0
Near West – Ultrathickened tailings storage facility (Alternative 3)	Roads and berms necessary to support the reclamation and closure; *concurrent reclamation of cyclone sand embankment slopes PAG ponds evaporated over time; NPAG and PAG tailings slopes and surfaces covered in in erosion-resistant capping material (growth medium)*	P: Excavation with and without soil salvage S: Structural loss; No disturbance	5,086 (10,033)	4	0

continued

Table 3.3.4-2. Disturbance, reclamation, and revegetation outcomes by facility and tailings alternative *(cont'd)*

Facility or Alternative	Facilities or Disturbance Remaining Post-decommissioning; Other Reclamation Considerations*	Primary (P) and Secondary (S) Disturbance Response Groups	Total Facility Disturbance (acres) and Impacts on Productivity†	High Water Erosion Potential (acres)‡	High Wind Erosion Potential (acres) ‡§
Silver King (Alternative 4)	Upstream stormwater diversion features (cutoff walls and channels); roads and berms necessary to support the reclamation and closure; *concurrent reclamation of sloped face of stacks; store and release cover design; tailings covered in in erosion-resistant capping material (growth medium)*	P: Excavation with and without soil salvage S: Structural loss; No disturbance	5,779 (10,861)	2	0
Peg Leg (Alternative 5)	Stormwater diversion channels, dropchutes, cutoff walls; roads and berms necessary to support the reclamation and closure; *reclamation begins at end of mine operations; PAG covered in 10 feet of NPAG material; all tailings covered in 1 to 2 feet of erosion-resistant capping material (growth medium)*	P: Excavation with and without soil salvage S: Structural loss; No disturbance	East pipeline option: 12,232 (17,153) West pipeline option:12,574 (17,530)	East pipeline option:204 West pipeline option: 562	East pipeline option: 3 West pipeline option: 47
Skunk Camp (Alternative 6)	Upstream stormwater diversion features (diversion walls, channels, and other stormwater control elements); roads and berms necessary to support the reclamation and closure; *reclamation begins at end of mine operations; PAG covered in 10 feet of NPAG material; all tailings covered in 1 to 2 feet of erosion-resistant capping material (growth medium)*	P: Excavation with and without soil salvage S: Structural loss; No disturbance	North pipeline option: 9,830 (16,116) South pipeline option: 10,269 (16,557)	North pipeline option: 7,768 South pipeline option: 8,117	North pipeline option: 735 South pipeline option: 735

* All disturbed surfaces not covered by a permanent structure would be reclaimed and revegetated; reclamation and decommissioning plans are detailed in chapter 2.

† The acreage shown in parentheses represents the total disturbed acreage for the entire project, which includes areas such as the East Plant Site and subsidence area. The acreage not in parentheses represents the disturbed acreage that is likely to be revegetated—the tailings storage facility and pipeline corridors—and represents an area that may recover productivity in the future.

‡ Wind and water erosion potential are provided as the total acreage for an entire facility or alternative. Details on how erosion susceptibility was determined are provided in Newell (2018g).

§ No wind erosion data are available where SSURGO data are unavailable.

- plant community fragmentation; and
- changes in plant growth and seasonal phenology from artificial lighting.

Vegetation Communities

Vegetation removal could have a variety of effects on vegetation communities ranging from changes in community structure and composition within the project footprint to alteration of soils. This could result in further loss of soil and vegetation, as well as increased sediment input to water resources. This impact would occur in localized areas of disturbance.

Soil disturbance may lead to the increased potential for the introduction and colonization of disturbed areas by noxious and invasive plant species, which may lead to changes in vegetation communities, including a possible shift over time to more wildfire-adapted vegetation that favors noxious or invasive exotic species over native species. This potential impact would be greatest in vegetation communities that are not adapted to fire, such as Arizona Upland and Lower Colorado River subdivisions of Sonoran Desertscrub. In more fire-adapted communities, such as Interior Chaparral and Semidesert Grasslands, these impacts could still occur, but the intensity of the impacts would decrease as native vegetation in these communities may respond positively to fire.

Fugitive dust from construction activities has the potential to affect photosynthetic rates and decrease plant productivity. Dust can have both physical and chemical impacts (Farmer 1993; Goodquarry 2011; Havaux 1992; Sharifi et al. 1997; Thompson et al. 1984; Walker and Everett 1987). Physical impacts of windborne fugitive dust on plants could include blockage and damage to stomata, shading, and abrasion of leaf surface or cuticle. Dust can increase leaf temperature; inhibit pollen germination; reduce photosynthetic activity, respiration, transpiration, and fruit set; decrease productivity; alter community structure; and contribute to cumulative impacts (e.g., drought stress on already stressed species or allow the penetration of phytotoxic gaseous pollutants, such as sulfur dioxide, nitrogen dioxide, and ozone). Some studies, however, indicate that plant species living in high light conditions are flexible to adapting to lower light conditions (e.g., desert plants) (Alves et al. 2002; Barber and Andersson 1992; Werner et al. 2002) and that some plant species show improved growth with increased dust deposition (i.e., limestone) (Brandt and Rhoades 1972). The overall impact on vegetation from fugitive dust would be localized near sources of dust and would be highest near areas of ground disturbance during construction activities and would decrease with the completion of construction activities.

The construction of project facilities would fragment vegetation communities and create edge areas. Edge areas have different microclimatic conditions and structure and may be characterized by compacted soils and increased runoff that can lead to changes in species composition and vegetation structure.

Artificial lighting associated with the construction phase of the proposed project is less defined but is assumed to be less intense that associated with the operations phase and to vary in location and intensity through the 1- to 9-year time period. Specific impacts would be similar to those described in the Operational Impacts section; impacts on species groups are also provided in subsequent sections.

Special Status Plant Species

The primary direct and indirect impacts on special status plant species during construction of the proposed project would be similar to those described in this section for vegetation communities and would be associated with

- removal and/or crushing of special status plant species from construction of project facilities,
- increased potential for noxious and invasive weed establishment and spread,
- decreased plant productivity from fugitive dust,
- plant community fragmentation,

- changes in plant growth and seasonal phenology from artificial lighting, and
- inability to reestablish pre-mining populations.

Vegetation removal and ground disturbance may affect special status plant species through decreased productivity from fugitive dust and the potential for changes to habitat from a decline in productive soils and from the increased potential for noxious and invasive weed establishment and spread.

All action alternatives would impact Arizona hedgehog cactus (*Echinocereus triglochidiatus* var. *arizonicus*) through direct loss of individual plants where they occur as well as habitat changes from subsidence at the East Plant Site and Oak Flat site as well as other ground-disturbing activities. The likelihood of reestablishment is unknown.

Noxious Weeds

The primary direct and indirect impacts associated with noxious weeds during construction of the proposed project would be associated with

- increased potential for introduction and spread of noxious and invasive weeds,
- changes to habitat from noxious and invasive weed establishment and spread, and
- direct and indirect impacts on and competition with native vegetation and special status plant species.

The proposed project, under any action alternative, would increase the potential for noxious weed cover, and produce vegetation assemblages that could alter natural fire regimes. Noxious weeds are often fire adapted and so perpetuate increased fire risk once established or following a fire. However, these impacts would be minimized on Tonto National Forest-administered lands with the implementation of the “Resolution Copper Project Noxious Weed and Invasive Species Management Plan on National Forest System Lands” (Resolution Copper 2019).

This impact would be highly likely to occur in areas disturbed by construction activities and is possible in adjacent habitats.

Operations

Vegetation Communities

Operation of the proposed mine and associated facilities would result in impacts on vegetation communities. The primary impacts of operations would be associated with

- subsidence,
- potential reduction in surface water flows and groundwater availability to riparian vegetation,
- increased potential for noxious and invasive weed establishment and spread,
- decreased plant productivity from fugitive dust, and
- changes in plant growth and seasonal phenology from artificial lighting.

During the operations phase of the proposed mine there would be impacts on vegetation communities from subsidence. Subsidence of the ground surface is anticipated to occur beginning approximately 6 years after initiation of mining activities. It is anticipated to continue until approximately 40 years after initiation of mining activities.

Within the cave zone, the development of a subsidence area would change the slope, aspect, surface water flow direction and rate; surface elevation; and would impact the seed bank on approximately 1,329 acres. This would likely modify the vegetation communities within portions of the cave limit. Within the fracture limit (1,579 acres), the potential impacts would be similar to the cave limit; however, the intensity would be decreased as this area would have reduced surface

impacts. The zone of continuous subsidence (1,686 acres) would have limited potential for localized impacts on vegetation communities as it would have minimal surface impacts.

In areas near the mine site, water usage would reduce water in the regional aquifer and would reduce surface water and groundwater levels downstream of the mine in Devil's Canyon and Queen Creek. Surface water amounts would be reduced, and timing/persistence of surface water would decrease. These potential decreases in groundwater and surface water would occur over a long period of time but could cause changes in riparian vegetation extent or health, and the reduction in stream flow could impact aquatic plant species, which need standing or flowing water or moist soils. As a result, the amount or volume of water within perennial pools or moisture in soils could decrease, which could result in indirect impacts on riparian vegetation and sensitive plant species through long-term habitat alteration, causing changes in the health of individual plants or populations, or even death and long-term elimination of certain plant species at these locations. Potential impacts from all action alternatives on vegetation communities in the analysis area could result from decreased surface water flow and groundwater drawdown, which could convert vegetation communities to those that are better adapted to drier conditions and result in long-term changes in the health of and reductions in the extent of riparian vegetation. Impacts on these groundwater-dependent ecosystems are analyzed in detail in section 3.7.1.

No impacts on vegetation communities are anticipated from water quality impacts at any of the tailings locations during operations as any stormwater that comes in contact with the tailings piles would be contained in the tailings facilities or in seepage ponds downstream. Water quality impacts associated with seepage that potentially could reach surface waters is analyzed in detail in section 3.7.2; specific impacts on vegetation communities are not anticipated from the potential increases in metals in surface water described in that section.

Potential impacts on vegetation communities from increased noxious and invasive weed establishment and spread would be similar in nature to those described earlier in this section for the construction phase; however, as ground-disturbing activities would be reduced during the operations phase, the magnitude of potential impacts would be greatly reduced.

Potential impacts on vegetation communities from fugitive dust would be similar in nature to those described earlier in this section for construction; however, the magnitude of impacts would be reduced as dust-producing activities would be less during the operations phase.

Artificial lighting associated with the operations phase of the proposed project would increase overall brightness in the night sky by 1 to 9 percent; therefore, impacts on plant species may occur. However, these impacts are not well understood or researched in current literature since much of the literature focuses on non-light-emitting diode (LED) lights. One thing that is known about LED lights and plants is that LED lights are best for growing plants indoors (Mitchell and Sutte 2015). Additionally, the potential impacts, if realized, would be associated within the direct vicinity of the main operations areas, i.e., where the most lights are concentrated to increase overall night-sky brightness. The potential impacts from light would lessen with distance from the light source. The main impact on plant species of lighting associated with the operations phase of the proposed project is through the plants' photoreceptors, and since plants are not mobile, they cannot move away from stimuli like this. The addition of artificial light at night could impact seed germination, stem elongation, leaf expansion, induce flowering, flower development, fruit development, and leaf senescence, i.e., loss of a cell's power of division and growth (Briggs 2006). In addition, artificial night lighting may lead to changes in plant growth and seasonal phenology as well as the interaction between some species and pollinators (Bennie et al. 2016). This may lead to decreased fitness of some plant species and could lead to changes in plant community structure over time near areas with artificial lighting. These impacts would be greatest near light sources and would decrease with distance from the sources.

Special Status Plant Species

Under all action alternatives, special status plant species, including Arizona hedgehog cactus, may be impacted during operations through subsidence; increased potential for noxious and invasive weed establishment and spread; fugitive dust; and changes in plant growth and seasonal phenology from artificial lighting.

Within the subsidence area, individual Arizona hedgehog cactus may be destroyed during subsidence events in the cave limit and to a lesser extent within the fracture limit. Within the cave limit and to a lesser extent the fracture limit, the changes to existing habitat could create and/or remove habitat suitable for Arizona hedgehog cactus and other species status plant species.

Potential impacts on special status plant species from noxious and invasive weed establishment and spread, fugitive dust, and artificial lighting would be similar in nature to those described earlier in this section for vegetation communities; however, the magnitude of impacts would be greater for special status plant species as they generally have more specific habitat requirements, smaller ranges, and smaller population size.

Noxious Weeds

Potential impacts from noxious weeds during operations would be similar in nature to those previously described for the construction phase; however, as there would be less ground disturbance during operations, the magnitude of impacts would be reduced. However, these impacts would be minimized on Tonto National Forest–administered lands with the implementation of the "Resolution Copper Project Noxious Weed and Invasive Species Management Plan on National Forest System Lands" (Resolution Copper 2019).

Closure and Reclamation Impacts

Closure and reclamation of the proposed mine and associated facilities would result in short- and long-term impacts on vegetation and soil resources. During this phase, facilities would be decommissioned, sites would be regraded (as needed) and reclaimed, soil or capping material would be applied along tailings and other surfaces (as needed), erosion control measures would be implemented, and disturbed areas would be revegetated. The goal of this phase would be to reestablish vegetation on all disturbed areas, to reduce soil erosion potential, and, over time, create stable, functioning ecosystems. Specific details regarding the potential to reestablish stable, functioning ecosystems as they relate to the desired future conditions identified by the Forest Service (described earlier) are discussed in the following sections. Note that the physical stability and safety of the tailings facility are described in section 3.10.1.

POTENTIAL TO ACHIEVE DESIRED FUTURE CONDITIONS

Projecting the outcomes of reclamation and the potential to achieve desired future conditions can be challenging for any project because several factors, including precipitation, temperature, topography, existing native and non-native seedbank), type and magnitude of disturbance, and reclamation methods (e.g., planting/seeding methods, weed management, soil salvage or capping media), all interact to influence success of revegetation efforts (see Bengtson (2019b)). While the meta-analysis does provide some constraint on revegetation trends that could be expected on a mining facility (see "Expected Effectiveness of Reclamation Plans" earlier in this section and Bengtson (2019b)), this analysis only addresses potential vegetation cover, and not the function of the ecosystem as a whole, including all of its biotic and abiotic components. A conservative strategy to estimate the time required to reach desired future conditions is to constrain natural rates of recovery from disturbance (in the absence of revegetation or other management interventions), because natural recovery estimates reflect the potential outcomes if reclamation efforts fail to accelerate vegetation reestablishment.

In a comprehensive investigation of natural recovery from 47 studies in the Mojave and Sonoran Deserts, Abella (2010) estimated that perennial plant cover requires 76 years to recover, and complete recovery of pre-disturbance species compositions would require, on average,

215 years. Another literature review from the Mojave and Sonoran Deserts estimated that biomass recovery may require 50 to 300 years, and complete recovery of the functioning ecosystem could require up to 3,000 years (Lovich and Bainbridge 1999). These two studies include results from many types of disturbance with differing levels of disturbance magnitude (Abella 2010; Lovich and Bainbridge 1999) with varying environmental conditions that can impact recovery rates (e.g., soil type, landform, and physical attributes of the site); see Lathrop and Archbold (1980). Despite the disparate estimates in natural recovery rates, there are two notable observations that have implications for projecting trends toward desired future conditions.

First, recovery generally follows natural succession, which is the "sequential, directional changes in species composition of a vegetation assemblage" (Webb et al. 1988). While short-lived, early-succession communities may recovery in a matter of a few years to decades (Abella 2010; Lathrop and Archbold 1980; Prose et al. 1987), recovery for some long-lived, late-succession plant communities could require thousands of years, following the sequence of soil development (Lovich and Bainbridge 1999; Webb et al. 2003; Webb et al. 1988).

Second, the type and magnitude of disturbance strongly influences the nature and rates of ecosystem recovery (Abella 2010; Webb et al. 1987). For example, recovery of ground-clearing disturbances requires more time than other non-ground-clearing disturbances, because ground clearing can severely compact soils or remove surface resources (e.g., seedbank, microbial communities, fertile islands, nutrients, biotic soils, desert pavements, etc.) (Abella 2010). Likewise, the type and intensity of ground disturbance can influence recovery (Abella 2010; Lovich and Bainbridge 1999). For example, excavation disturbance generally requires approximately 100 years to recover pre-disturbance levels of biomass, and less-intense disturbance that only disrupts surface soils may require only around 20 years for biomass recovery (Lathrop and Archbold 1980). Ground disturbance impacts may be species specific, as soil compaction, topsoil removal, and changes to ephemeral drainages seems to hinder recovery of longer lived species or those sensitive to soil compaction (Prose et al. 1987). The shape of the disturbance footprint may also play a role, as some research suggests that recovery of linear disturbances (i.e., roads, pipeline corridors, transmission line corridors), is accelerated by the availability of seeds and propagules from adjacent undisturbed areas, whereas wider or larger disturbance areas lack nearby propagule sources (Abella 2010).

The findings of these natural recovery studies, the outcomes of the meta-analysis (Bengtson 2019b), and species-specific resource studies have been used to constrain the potential for reclamation efforts to achieve desired future conditions. Trends toward desired future conditions largely vary based on the level and nature of disturbance across all project components (see table 3.3.4-1). In general, fast-growing and early-successional plant species and those tolerant of a variety of conditions would be the first to reestablish after reclamation, recovering over years to decades. In contrast, some slower growing, late-successional species may also reestablish but may require centuries or even millennia to reach pre-disturbance levels of ecosystem function. In areas where ground disturbance is relatively low, and soil resources (e.g., nutrients, organic matter, microbial communities) and vegetation propagules (e.g., seedbank or root systems to resprout) remain relatively intact, it would be expected that vegetation communities could rebound to similar pre-disturbance conditions in a matter of decades to centuries. In contrast, the tailings storage facility, which would be covered in non-soil capping material (such as Gila Conglomerate) would provide, at best, some habitat structure for generalist wildlife species. It is expected that biodiversity and ecosystem function of the tailing storage facility may never reach the original, pre-disturbance conditions even after centuries of recovery. The following sections detail the estimated potential, as well as some time constraint, for individual vegetation communities to reach their respective desired future conditions and potential impacts on soil resources, special status plant species, and noxious weeds.

Soils

Healthy soils are the basis for a stable, functioning ecosystem—providing a plant growth medium, habitat for burrowing animals, water and nutrients to support plant communities, and harboring seeds and

plant propagules. During the closure and reclamation project phase, the reestablishment of vegetation and improvements to soil conditions (through soil management or application of amendments) would offset impacts from construction, operations, and maintenance.

Even with optimal soil management intervention, the legacy of impacts on soil health and productivity may last centuries to millennia, impacting the ability of the ecosystem to meet its desired future conditions. For example, natural recovery from compaction (associated with heavy equipment traffic) is estimated to require 92 to 124 years (Webb 2002). Similarly, biotic soils and desert pavements, which trap fine-grained dust to form vesicular soil horizons, naturally prevent erosion, influence the distribution of soil nutrients, and control soil water dynamics, develop over hundreds to thousands of years (Anderson et al. 2002; Felde et al. 2014; Haff and Werner 1996; Williams 2011; Williams et al. 2012; Williams et al. 2013). The following impacts on soils would be expected during and in the years following closure and reclamation:

- Losses of topsoil resources (e.g., fine-grained soil particles, soil fertility, compaction, natural soil structure, water-holding capacity, biotic soils) during construction, operations, and maintenance may be considered permanent, as these resources accumulate over hundreds to thousands of years of soil formation. It is expected that erosion control and revegetation efforts during closure and reclamation would stop the continued loss of these resources.
- Some soil function may be enhanced through application of soil amendments (e.g., mulch, organic matter application) by increasing soil fertility, erosion resistance, and soil water-holding capacity, which would improve soil productivity.
- Over time, as soil formation proceeds (over hundreds to thousands of years), soil health and function would improve as dust accretes to increase natural soil fertility and water-holding capacity, soil structure redevelops and improves soil hydrologic function, organic matter and nutrients accumulate, bioturbation mixes soil resources, plants and microorganisms continue to colonize soils, biotic soils and desert pavements reform, and carbon and nitrogen are fixed within the soil.
- The productivity of the soil and its ability to support healthy and resilient vegetation communities (which meet an ecosystem's desired future conditions) would increase as soil formation proceeds over centuries and millennia.

These changes to soil function and productivity through time are considered in the following sections that detail the potential to achieve desired future conditions. The time frames for the recovery of soil function would largely depend on the initial level of disturbance (see table 3.3.4-1), with those soils that have had the least-impacted disturbance type (and have the greatest soil resources remaining) recovering the fastest.

Desert Ecosystems

Under optimal conditions, and with sufficient revegetation efforts and resource inputs (e.g., soil amendments and watering), fast-growing perennial shrubs, forbs, grasses, cacti, and mesquite trees would rebound within a few years to a few decades. Saguaro are slow-growing, and larger (older) individuals have low transplant survival rates (Elliot 2003). Managing the fine fuels associated with non-native grasses to maintain fire intervals greater than 100 years may not be possible, even in undisturbed and low-disturbance areas. Overall, the habitat may be suitable for generalist wildlife and plant species, but rare plants and wildlife with specific habitat requirements would be unlikely to return.

Semi-desert grasslands

Under optimal conditions, and with sufficient revegetation efforts and resource inputs (e.g., soil amendments and watering), many native grasses would return within a few years to a few decades. Tree and shrub canopy cover can be limited with management intervention. Managing non-native vegetation cover to limit the intensity of uncharacteristic fires may not be possible on the landscape scale. Because many important

grass species would recover in the short-term, much of the habitat function of these ecosystems would be likely to return.

Interior Chaparral

Under optimal conditions, and with sufficient revegetation efforts and resource inputs (e.g., soil amendments and watering), recovery of shrubs (particularly shrub live oak, see (Tirmenstein 1999)), shrub litter, and regeneration of grasses and forbs should be achievable over decades to centuries on most disturbance types other than the tailings storage facility. While management of non-native species may not be achievable, support of stand-replacing fires at 35- to 100-year intervals that promote resprouting of fire-adapted species may be achievable with management interventions. Much of the habitat function should return to these habitats after decades to centuries for generalist species but may not return for sensitive species with specific habitat requirements.

Pinyon-Juniper Woodland

Under optimal conditions, reestablishment of multi-aged woodlands with complex structure and sparse ground cover of shrubs, perennial grasses, and forbs would be achievable with management intervention and resource inputs for most disturbance types, with the exception of the tailings storage facility. However, very old trees would take centuries to reestablish. Support of low-intensity ground fires should be possible with management intervention. Habitat structure would return for most generalist wildlife species but would likely require decades to centuries.

Ponderosa Pine-Evergreen Oak

Given optimal conditions, revegetation efforts, management interventions, and resource inputs, reestablishment of old-growth tree stands with sparse shrub and herbaceous groundcover should be achievable on most disturbance types with the exception of the tailings storage facility. Recreating a functional ecosystem that is resilient to a variety of human and natural disturbances may be challenging to achieve, even with intense management interventions. Habitat structure would return for most generalist wildlife species but would likely require decades to centuries.

Xeroriparian

With maintenance or recovery of the optimal hydrologic conditions, and with some management interventions, the reestablishment of most xeroriparian communities would return for all disturbance types with the exception of the tailings storage facilities. However, these communities may recover around the tailings facilities, under the appropriate conditions. Habitat structure would return for most generalist wildlife species but would likely require decades to centuries.

Riparian

Riparian community composition is expected to vary based on soil and hydrologic conditions, however, in general site-appropriate communities are expected to reestablish (given suitable management intervention and revegetation efforts) on all disturbance types with the exception of the tailings storage facilities. However, these communities may reestablish adjacent to the tailings storage facility. Habitat structure would return for most generalist wildlife species but would likely require decades to centuries.

Special Status Plant Species

Impacts on special status plant species during closure/reclamation would be similar to those described for vegetation communities. However, as special status plant species generally have specific habitat requirements, it is unlikely that reclaimed areas would retain or develop those habitat requirements over more than a small portion of the areas previously disturbed.

Noxious Weeds

Reclamation of disturbed areas would decrease but not eliminate the likelihood of noxious weeds becoming established or spreading in

and adjacent to the project area. In areas where reclamation activities would occur, there would likely be reduced soil stability and an initial increase in the potential for noxious and invasive weed establishment and spread due to ground disturbance and decreased competition for space, light, and water. Efforts to reclaim these areas would lessen the potential for weed establishment and spread in the long term; however, it is anticipated that reclaimed areas would have a higher density of these non-native species than were present before ground-disturbing activities, even at completion of reclamation activities.

3.3.4.3 Alternative 2 – Near West Proposed Action

Potential impacts on soils, vegetation communities, and special status plant species, as well as impacts from noxious weeds, would be as described earlier under "Impacts Common to All Action Alternatives" and "Potential to Achieve Desired Future Conditions." Alternative 2 would remove or modify approximately 10,033 acres of vegetation and impact 10,033 total acres of soils (see table 3.3.4-2). Of the disturbed area, 5,084 acres would potentially be revegetated and would recover productivity to some extent, as described under "Impacts Common to All Action Alternatives." The acres of potential impacts on vegetation communities and special status plant species habitat by alternative are given in tables 3.3.4-3 and 3.3.4-4.

Financial Assurance for Closure and Post-Closure Activities

Alternative 2 potentially involves long time periods of post-closure maintenance and monitoring related to revegetation and reclamation of the tailings storage facility. This raises the concern for the possibility of Resolution Copper going bankrupt or otherwise abandoning the property after operations have ceased. If this were to happen, the responsibility for these long-term activities would fall to the Forest Service. The Forest Service would need to have financial assurance in place to ensure adequate funds to undertake these activities for long periods of time—for decades or even longer.

The authority and mechanisms for ensuring long-term funding is discussed in section 1.5.5. The types of activities that would likely need to be funded could include the following:

- Monitoring of the success of revegetation
- Implementing remedial actions if revegetation success criteria are not met
- Monitoring of the post-closure landform for excessive erosion or instability, and performance of any armoring
- Maintenance and monitoring of post-closure stormwater control features
- Monitoring the water quality of stormwater runoff associated with the closure cover, to determine ability to release stormwater back to the downstream watershed

Additional financial assurance requirements for long-term maintenance and monitoring are part of the Arizona APP program and include the following:

> The applicant or permittee shall demonstrate financial responsibility to cover the estimated costs to close the facility and, if necessary, to conduct postclosure monitoring and maintenance by providing to the director for approval a financial assurance mechanism or combination of mechanisms as prescribed in rules adopted by the director or in 40 Code of Federal Regulations section 264.143 (f)(1) and (10) as of January 1, 2014. (Arizona Revised Statutes 49-243; also see Arizona Administrative Code R18-9-A203 for specific regulations and methods allowed for financial assurance)

Table 3.3.4-3. Acres of vegetation communities to be disturbed within each action alternative footprint

Vegetation Community or Landform Type	Alternative 2 (acres)	Alternative 3 (acres)	Alternative 4 (acres)	Alternative 5 West Pipeline Option (acres)	Alternative 5 East Pipeline Option (acres)	Alternative 6 South Pipeline Option (acres)	Alternative 6 North Pipeline Option (acres)
Total Acres	**10,033**	**10,033**	**10,861**	**17,530**	**17,153**	**16,557**	**16,116**
Human dominated	410	410	410	423	423	423	410
Interior Chaparral	1,251	1,251	1,379	1,251	1,257	2,564	2,654
Lower Colorado River Sonoran Desertscrub	1,619	1,619	3,592	2,399	2,451	2,572	2,535
Pine-Oak	2	0	3	2	2	18	48
Pinyon-Juniper	44	0	83	118	133	92	116
Riparian	28	28	44	35	35	92	90
Semidesert Grassland	137	135	1,417	143	149	7,041	7,045
Arizona Upland Sonoran Desertscrub	6,393	6,393	3,706	12,976	12,494	2,866	2,438
Water	14	15	15	15	15	15	15
Xeroriparian	135	135	184	171	195	813	766

Note: Acreages in this table are rounded to the nearest whole number.

The Arizona State Mine Inspector also has authority to require a mine reclamation plan and financial assurance for mine closure (Arizona Administrative Code Title 11, Chapter 2). The regulations for these focus primarily on surface disturbance and revegetation.

3.3.4.4 Alternative 3 – Near West – Ultrathickened

Potential impacts on soils, vegetation communities, special status plant species, and noxious weeds would be the same in magnitude and nature as those described for Alternative 2 as they have the same footprint, and differences in the tailings facility construction and operation would not increase or decrease potential impacts between the two alternatives.

Financial assurance for closure and post-closure activities would be the same as described for Alternative 2.

3.3.4.5 Alternative 4 – Silver King

Potential impacts on soils, vegetation communities, special status plant species, and from noxious weeds would be as described under “Impacts Common to All Action Alternatives” and “Potential to Achieve Desired Future Conditions.” Alternative 4 would remove or modify approximately 10,861 acres of vegetation and impact 10,861 total acres of soils (see table 3.3.4-2). Of the disturbed area, 5,779 acres would potentially be revegetated and would recover productivity to some extent, as described under “Impacts Common to All Action Alternatives” and “Potential to Achieve Desired Future Conditions.” The acres of potential impacts on vegetation communities and special status plant species habitat by alternative are given in tables 3.3.4-3 and 3.3.4-4.

Financial assurance for closure and post-closure activities would be the same as described for Alternative 2.

Table 3.3.4-4. Acres of modeled habitat for special status plant species potentially occurring within each action alternative footprint

Common Name (Scientific Name)	Status	Alternatives 2 and 3 (acres) Percentage of Modeled Habitat in Analysis Area Percentage of Modeled Habitat in 5-Mile Buffer Area	Alternative 4 (acres) Percentage of Modeled Habitat in Analysis Area Percentage of Modeled Habitat in 5-Mile Buffer Area	Alternative 5 West Pipeline Option (acres) Percentage of Modeled Habitat in Analysis Area Percentage of Modeled Habitat in 5-Mile Buffer Area	Alternative 5 East Pipeline Option (acres) Percentage of Modeled Habitat in Analysis Area Percentage of Modeled Habitat in 5-Mile Buffer Area	Alternative 6 South Pipeline Option (acres) Percentage of Modeled Habitat in Analysis Area Percentage of Modeled Habitat in 5-Mile Buffer Area	Alternative 6 North Pipeline Option (acres) Percentage of Modeled Habitat in Analysis Area Percentage of Modeled Habitat in 5-Mile Buffer Area
Acuña cactus (*Echinomastus erectocentrus* var. *acunensis*)	ESA: E with critical habitat. Found in Maricopa, Pinal, and Pima Counties	N/A 0% 0%	N/A 0% 0%	14,531 82% 5%	14,130 65% 5%	N/A 0% 0%	N/A 0% 0%
Arizona hedgehog cactus (*Echinocereus triglochidiatus* var. *arizonicus*)	ESA: E No critical habitat. Found in Maricopa, Pinal, and Gila Counties	2,2,594 13% 4%	2,857 17% 4%	2,594 21% 5%	52,617 20% 5%	2,698 17% 7%	5,597 18% 7%
Chiricahua Mountain alumroot (*Heuchera glomerulata*)	Tonto National Forest: S	0 0% 0%	94 19% 1%	0 0% 0%	0 0% 0%	133 22% 1%	110 19% 1%

continued

Table 3.3.4-4. Acres of modeled habitat for special status plant species potentially occurring within each action alternative footprint *(cont'd)*

Common Name (Scientific Name)	Status	Alternatives 2 and 3 (acres) Percentage of Modeled Habitat in Analysis Area Percentage of Modeled Habitat in 5-Mile Buffer Area	Alternative 4 (acres) Percentage of Modeled Habitat in Analysis Area Percentage of Modeled Habitat in 5-Mile Buffer Area	Alternative 5 West Pipeline Option (acres) Percentage of Modeled Habitat in Analysis Area Percentage of Modeled Habitat in 5-Mile Buffer Area	Alternative 5 East Pipeline Option (acres) Percentage of Modeled Habitat in Analysis Area Percentage of Modeled Habitat in 5-Mile Buffer Area	Alternative 6 South Pipeline Option (acres) Percentage of Modeled Habitat in Analysis Area Percentage of Modeled Habitat in 5-Mile Buffer Area	Alternative 6 North Pipeline Option (acres) Percentage of Modeled Habitat in Analysis Area Percentage of Modeled Habitat in 5-Mile Buffer Area
Mapleleaf false snapdragon (*Mabrya [Maurandya] acerifolia*)	Tonto National Forest: S	0 0% 0%	0 0% 0%	737 3% 1%	319 3% 1%	0 0% 0%	0 0% 0%
Parish's Indian mallow (*Abutilon parishii*)	Tonto National Forest: S BLM: S	1,463 23% 4%	4,999 99% 17%	4,874 39% 18%	5,011 29% 8%	3,395 23% 7%	3,245 33% 8%
Pringle's fleabane (*Erigeron pringlei*)	Tonto National Forest: S	1,305 20% 4%	1,439 16% 3%	1,305 20% 4%	1,310 19% 4%	2,676 16% 5%	2,770 18% 5%

Notes: Modeled habitat includes areas outside of the current range of some species and is used here as a conservative estimate of impacts. It was necessary to use modelled habitat since the only baseline survey and suitable habitat data available were only for four species within Alternatives 2 and 3. Acreages in this table are rounded to the nearest whole number.

Status Definitions

Tonto National Forest:

S = Sensitive. Species identified by a Regional Forester for which population viability is a concern, as evidenced by a significant current or predicted downward trends in population number or density or significant current or predicted downward trends in habitat capability that would reduce a species' existing distribution.

Endangered Species Act (ESA):

E = Endangered. Endangered species are those in imminent jeopardy of extinction. The ESA specifically prohibits the take of a species listed as endangered. Take is defined by the ESA as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to engage in any such conduct.

Bureau of Land Management (BLM):

S = Sensitive. Species that could easily become endangered or extinct in the state.

3.3.4.6 Alternative 5 – Peg Leg

Potential impacts on soils, vegetation communities, special status plant species, and from noxious weeds would be as described under "Impacts Common to All Action Alternatives." Alternative 5 would remove or modify approximately 17,153 acres of vegetation with the east pipeline route option and 17,530 acres with the west pipeline route option. The disturbance would impact 17,153 acres of soils in the east pipeline route option and 17,530 acres of soils for the west pipeline route option (see table 3.3.4-2). Of the disturbed area, just over 12,000 acres would potentially be revegetated and would recover productivity to some extent, as described under "Impacts Common to All Action Alternatives" and "Potential to Achieve Desired Future Conditions." The acres of potential impacts on vegetation communities and special status plant species habitat by alternative are given in tables 3.3.4-3 and 3.3.4-4. Within Alternative 5, both the east and west pipeline options would impact critical habitat. The west pipeline option would disturb around 103 acres of acuña cactus critical habitat, and the east pipeline option would disturb about 12 acres of critical habitat.

The regulatory framework under the State of Arizona to require financial assurance for long-term closure activities is the same as described for Alternative 2. However, for the tailings facility, financial assurance requirements would be required by BLM, not the Forest Service. Like the Forest Service, BLM also has regulatory authority to require financial assurance for closure activities, contained in their surface management regulations (43 CFR Subpart 3809). BLM considers that the financial assurance must cover the estimated cost as if BLM were hiring a third-party contractor to perform reclamation of an operation after the mine has been abandoned. The financial assurance must include construction and maintenance costs for any treatment facilities necessary to meet Federal and State environmental standards.

3.3.4.7 Alternative 6 – Skunk Camp

Potential impacts on soils, vegetation communities, special status plant species, and from noxious weeds would be as described under "Impacts Common to All Action Alternatives" and "Potential to Achieve Desired Future Conditions." Alternative 6 would remove approximately 16,557 acres of vegetation for the south pipeline route option and 16,116 acres for the north pipeline route option. The disturbance would impact 16,116 acres of soils in the north pipeline route and 16,557 acres of soils for the south pipeline route (see table 3.3.4-2). Of the disturbed area about 10,000 acres would potentially be revegetated and would recover productivity to some extent, as described under "Impacts Common to All Action Alternatives." The acres of potential impacts on vegetation communities and special status plant species habitat by alternative are given in tables 3.3.4-3 and 3.3.4-4.

The regulatory framework under the State of Arizona to require financial assurance for long-term closure activities is the same as described for Alternative 2. However, Alternative 6 differs from the other alternatives because the tailings facility would not be located on lands managed by the Forest Service (as in Alternatives 2, 3, and 4) or BLM (Alternative 5). For Alternative 6, the Federal financial assurance mechanisms would not be applicable.

3.3.4.8 Cumulative Effects

The assessment area for cumulative impacts on soils and vegetation in conjunction with the Resolution Copper Project is broadly defined as the "Copper Triangle" region of south-central Arizona (generally understood as encompassing lands from the Globe-Miami area southwest to the town of Superior and southeast to the towns of Hayden and Winkelman), as well as adjacent watersheds.

In assessing cumulative effects on soils and vegetation, it should be understood that all forms of surface disturbance have the potential to remove or damage vegetation and increase soil erosion in the immediate vicinity of the disturbance and possibly beyond. Loss of vegetation leads to potential habitat losses that may last hundreds or thousands of years, as natural recovery proceeds. Intensified or accelerated erosion may occur through the effects of wind, or water, or both, causing permanent losses of soils and soil resources. Vegetation destruction, habitat loss, and increased erosion may occur whether the surface disturbance is intentional, such as that resulting from a construction project, or

incidental, such as that arising from OHV use or other recreational activity in previously undisturbed areas.

The Tonto National Forest identified the following list of reasonably foreseeable future actions as likely to occur in conjunction with development of the Resolution Copper Mine and as having potential to contribute to incremental changes to soils and vegetation. As noted in section 3.1, past and present actions are assessed as part of the affected environment; this section analyzes the effects of any RFFAs, to be considered cumulatively along with the affected environment and Resolution Copper Project effects.

- *Pinto Valley Mine Expansion.* The Pinto Valley Mine is an existing open-pit copper and molybdenum mine located approximately 8 miles west of Miami, Arizona, in Gila County. Pinto Valley Mining Corporation is proposing to expand mining activities onto an estimated 1,011 acres of new disturbance (245 acres on Tonto National Forest land and 766 acres on private land owned by Pinto Valley Mining Corporation) and extend the life of the mine to 2039. EIS impact analysis is pending. However, it is assumed that the proposed action as described in the recently amended mining plan of operations would result in the direct short-term (less than 5 years) or long-term (20–30 years) loss of soils and vegetation through surface disturbance of up to 1,011 acres. Some areas could later be reclaimed and revegetated, but there would also be the permanent, irreversible loss of other areas that would, for example, be buried beneath expanded tailings impoundments or waste-rock stockpiles or would be permanently lost to expansion of the pit area. In addition, given what is known of the historical environmental effects of similar mining operations elsewhere, the potential exists for adverse effects on both soils and riparian vegetation communities downgradient of the mine due to contamination or decreased water availability. A more accurate assessment of the potential for downstream seepage or other contamination would not be known until the environmental effects analysis of the proposed mine expansion is complete and mitigation measures and other environmental controls are agreed upon between the Tonto National Forest, Pinto Valley Mining Corporation, and other Federal and State regulatory agencies.
- *Ripsey Wash Tailings Project.* Mining company ASARCO is planning to construct a new tailings storage facility to support its Ray Mine operations to replace the existing Elder Gulch tailings storage facility near Hayden, which is now nearing its maximum capacity. The environmental effects of the project were analyzed in an EIS conducted by the USACE and approved in a ROD issued in December 2018. As approved, the proposed tailings storage facility project would occupy an estimated 2,574 acres and be situated in the Ripsey Wash watershed just south of the Gila River approximately 5 miles west-northwest of Kearny, Arizona, and would contain up to approximately 750 million tons of material (tailings and embankment material). Development of the new facility would result in the permanent loss (i.e., burial) of existing soils and vegetation within the tailings storage facility boundary. Other existing surface soils and vegetation would, for approximately the next 50 years, be overlain by tailings storage facility maintenance roads, slurry and water pipeline corridors, and other supporting tailings facility infrastructure. Following facility closure, however, the majority of these linear facilities would be removed and the underlying soils and vegetation reclaimed. Cumulative effects with the Resolution Copper Project would be most pronounced for Alternative 5 – Peg Leg, which would result in large areas of impact on soil and vegetation in the same general vicinity and watershed.
- *Superior to Silver King 115-kV Relocation Project.* At the request of Resolution Copper, SRP intends to relocate an approximately 1-mile segment of the existing Superior-Silver King 115-kV transmission line, located on Resolution Copper–owned private property, approximately 0.25 mile to the northwest to accommodate future Resolution Copper Mine–related facilities. This relocation of the transmission line would directly affect relatively small areas of previously

undisturbed soil and vegetation to allow for installation of footings for transmission line poles and possibly of other areas for maintenance access. These activities could increase the potential for introduction and establishment of noxious weeds and invasive species along this portion of the transmission line corridor.

- *Silver Bar Mining Regional Landfill and Cottonwood Canyon Road.* A private firm, Mineral Mountain LLC, is proposing to develop a landfill on land the company owns approximately 6 miles southeast of Florence Junction and 4 miles due east of SR 79. This private land lies entirely within an area of BLM-administered lands and cannot be accessed without crossing Cottonwood Canyon Road, located on BLM lands. The company received Master Facility Plan Approval for the proposed landfill from ADEQ in 2009 and a BLM right-of-way grant in 2017. The firm's proposed construction on Cottonwood Canyon Road and on the landfill property could increase the potential for introduction and/or spread of noxious weeds and invasive plants. Approximately 4 acres of creosotebush-bursage vegetation and 11 acres of Arizona Upland Desertscrub would be removed to expand Cottonwood Canyon Road. Development of the landfill would result in the clearing of 350 acres of vegetation on private lands.
- *APS Herbicide Use within Authorized Power Line Rights-of-Way on NFS lands.* Arizona Public Service Company (APS) has proposed to include Forest Service-approved herbicides as a method of vegetation management, in addition to existing vegetation treatment methods, on existing APS transmission rights-of-way within the Tonto National Forest. An environmental assessment (EA) with a Finding of No Significant Impact (FONSI) was published in December 2018. The EA determined that environmental resource impacts would be minimal, and the use of herbicides would be useful in preventing and/or reducing fuel buildup that would otherwise result from rapid, dense regrowth and sprouting of undesired vegetation. No residual effects on underlying soils are anticipated as a result of use of these herbicides.
- *ADOT Vegetation Treatment***.** Like the APS vegetation control program, Arizona Department of Transportation (ADOT) plans to conduct annual treatments using EPA-approved herbicides to contain, control, or eradicate noxious, invasive, and native plant species that pose safety hazards or threaten native plant communities on road easements and NFS lands up to 200 feet beyond road easement on the Tonto National Forest. No residual effects on underlying soils are anticipated as a result of use of these herbicides.
- *Ray Land Exchange and Proposed Plan Amendment.* ASARCO is also seeking to complete a land exchange with the BLM by which the mining company would gain title to approximately 10,976 acres of public lands and federally owned mineral estate located near ASARCO's Ray Mine in exchange for transferring to the BLM approximately 7,304 acres of private lands, primarily in northwestern Arizona. It is known that at some point ASARCO wishes to develop a copper mining operation in the "Copper Butte" area west of the Ray Mine; however, no details are currently available for specific mine development plans or how these may directly or indirectly affect existing soils and vegetative communities in the Copper Butte area.
- *AGFD Wildlife Water Catchment Improvement Projects*. These individual catchment projects are part of a larger, longer term cooperative effort between the Tonto National Forest and Arizona Game and Fish Department to improve wildlife habitat throughout the Tonto National Forest, and specifically to benefit mule deer populations (although access to water provided by the catchments would also benefit elk, javelina, Gambel's quail, and other species). Each catchment array (including water storage tanks, a large "apron" to gather and direct precipitation to the storage tanks, drinking trough, and fencing) would disturb no more than 0.5 acre, causing minimal cumulative disturbance of soils and vegetation.

- *Tonto National Forest Travel Management Plan*. The Tonto National Forest is currently in the process of developing a Supplemental EIS to address certain court-identified deficiencies in its 2016 Final Travel Management Rule EIS. This document and its implementing decisions are expected within the next 2 years. This document will have substantial impacts on current recreational uses of Tonto National Forest lands and transportation routes, which in turn would have some impact on disturbance of soils and vegetation for new road construction or decommissioning of other roads.

Nearly all forms of human development activity involve some amount of short- or long-term surface disturbance of existing soils and vegetation. These activities may include agriculture, mining, roadbuilding, utility construction, private residential and commercial land development, rangeland improvements, and many other actions beyond the specific projects described here. Many of these types of earth-disturbing activities are certain to occur in this area of south-central Arizona during the foreseeable future life of the Resolution Copper Mine (50–55 years), including developments that have yet to be imagined or planned. In some instances, the disturbed soils and vegetation are eventually returned to approximately pre-disturbance conditions, but in most cases they are not.

3.3.4.9 Mitigation Effectiveness

The Forest Service is in the process of developing a robust mitigation plan to avoid, minimize, rectify, reduce, or compensate for resource impacts that have been identified during the process of preparing this EIS. Appendix J contains descriptions of mitigation concepts being considered and known to be effective, as of publication of the DEIS. Appendix J also contains descriptions of monitoring that would be needed to identify potential impacts and mitigation effectiveness. As noted in chapter 2 (section 2.3), the full suite of mitigation would be contained in the FEIS, required by the ROD, and ultimately included in the final GPO approved by the Forest Service. Public comment on the EIS, and in particular appendix J, will inform the final suite of mitigations.

This section contains an assessment of the effectiveness of design features from the GPO and mitigation and monitoring measures found in appendix J that are applicable to soils and vegetation.

Mitigation Measures Applicable to Soils and Vegetation

Salvage of select vegetation and trees within the tailings storage facility footprint (RC-208): To the extent practicable, Resolution Copper will salvage select vegetation and select suitable trees within the tailings storage facility footprint. This measure would be applicable to all alternative tailings storage facility locations and would be noted in the final ROD or final mining plan of operations as a requirement by the Forest Service.

Conduct soil surveys within the area to be disturbed by the preferred alternative tailings storage facility (FS-223): While adequate soil and vegetation information exists to conduct an assessment for the purposes of disclosing impacts under NEPA and comparing between alternatives, the level of information may not be sufficient to support detailed final reclamation plans and a final mining plan of operations. To support these documents, soil surveys need to be conducted within the disturbance footprint of the preferred alternative tailings storage facility. The specific purpose of the surveys would be to identify general soil characteristics, estimate the amount of soil or unconsolidated material that would be available for salvage to support reclamation activities, and inform the ability of salvaged material to support reclamation efforts. The appropriate level of detail for the soil survey would be determined in conjunction with the Tonto National Forest. The Forest Service is requiring that these surveys be conducted between the DEIS and FEIS. This exercise will inform the requirements to be specified in the ROD and ultimately incorporated into a final mining plan of operations.

Conduct appropriate testing of soil materials within the preferred alternative tailings storage facility (FS-224): Similarly, in order to

support detailed final reclamation plans and a final mining plan of operations, appropriate testing would be conducted on soil samples collected from within the Preferred Alternative footprint. These tests could include such parameters as soil organic carbon, moisture capacity, nutrients, pH/acidity/alkalinity. Tests would also include those appropriate to estimate post-closure water quality of stormwater runoff interacting with the salvaged soil. The appropriate suite of tests to be conducted would be determined in conjunction with the Tonto National Forest. The Forest Service is requiring that these tests be conducted between the DEIS and FEIS. This exercise will inform the requirements to be specified in the ROD and ultimately incorporated into a final plan of operations.

Conduct vegetation surveys within the preferred alternative disturbance footprint (FS-225): Also, in order to support detailed final reclamation plans and a final mining plan of operations, vegetation surveys need to be conducted within the disturbance footprint of the preferred alternative tailings storage facility. These surveys would identify general vegetation present, density, abundance of native/non-native species, and any special status plant species for which site characteristics are appropriate for occurrence. The appropriate level of detail for these surveys would be determined in conjunction with the Tonto National Forest. The Forest Service is requiring that these surveys be conducted between the DEIS and FEIS. This exercise will inform the requirements to be specified in the ROD and ultimately incorporated into a final plan of operations.

Preparation of detailed reclamation plans for the preferred alternative (FS-226): Information derived from the soil surveys, vegetation surveys, and soil testing would be used to develop detailed reclamation plans for the preferred alternative. These reclamation plans would be more specific than those included in the GPO, and would include such details as maps of the post-closure landform depicting the type of final closure cover for each area (depth of material, type of material, anticipated source of material and preparation methods like crushing or sorting, and need for/presence of armoring); anticipated reclamation techniques such as surface preparation, seeding, planting, watering (if any), soil amendments; soil salvage storage locations and storage management techniques; maps of the post-closure landform or the landform over time, depicting phasing of revegetation or reclamation activities; monitoring details including proposed success criteria and the potential use of comparison reference plots. The detailed reclamation plans would also include more specific information on post-closure stormwater controls, the anticipated longevity of engineered control systems, and criteria for when stormwater would be deemed appropriate for release back to the downstream drainages. The appropriate level of detail for the final reclamation plans would be determined in conjunction with the Tonto National Forest. The Forest Service is requiring that these plans be prepared between the DEIS and FEIS. This exercise will inform the requirements to be specified in the ROD and ultimately incorporated into a final mining plan of operations.

Mitigation Effectiveness and Impacts

The salvage of vegetation would not result in any additional ground disturbance and would be effective at offsetting some loss of vegetation through salvage and replanting. Not all salvaged vegetation would likely survive transplantation, and many decades might be required before areas are available for replanting. The amount of vegetation salvaged would be a small portion of that lost.

Soil surveys, soil testing, vegetation surveys, and preparation of detailed reclamation plans would not result in any additional ground disturbance and would be effective at developing information and techniques that would allow revegetation activities to be as successful as possible. These would also inform monitoring requirements that would ensure that revegetation activities are performing over time as predicted.

Unavoidable Adverse Effects

The mitigation described would only minimally offset project impacts. The unavoidable adverse effects remain as described earlier in this section, including the complete loss during operations of soil productivity, vegetation, and functioning ecosystems within the area of disturbance, and eventual recovery after reclamation (though not

likely to the level of desired conditions or potentially over extremely long time frames). Impacts on special status plant species, where they occur, and the spread of noxious and invasive weeds (though reduced by applicant-committed environmental protection measures) would also be unavoidable adverse effects.

3.3.4.10 Other Required Disclosures

Short-Term Uses and Long-Term Productivity

Productivity loss for soils would be limited to the disturbed areas affected by land clearing, grading, and construction; subsidence; and areas permanently occupied by tailings. It is not expected that the tailings would ever be removed, or that the subsidence crater would be filled, and effects on soils and some land uses would be permanent.

Reclamation efforts are anticipated to reestablish vegetation in all areas other than the subsidence crater.

Test plots at the West Plant Site have demonstrated that it is possible to successfully revegetate under certain conditions and research has demonstrated successful revegetation on Gila Conglomerate in the same geographic area; however, it is not known whether the areas would return to current conditions or the length of time that would be needed to successfully reclaim the site. However, the goal of reclamation is to create a self-sustainable ecosystem that would promote site stability and repair hydrologic function, and while pre-project habitat conditions are not likely to be achieved, it is likely that some level of wildlife habitat would eventually be reestablished in most areas, reestablishing some level of long-term productivity.

Irreversible and Irretrievable Commitment of Resources

Soils are a finite resource, and any loss of soils resulting from their removal for tailings storage and from erosion and delivery to downstream channels is irreversible. The loss of soil productivity is effectively irreversible because a stable new plant community would take an extremely long time to redevelop on the surface of the tailings and waste-rock facilities (decades or centuries). The area of the subsidence crater and tailings storage facility would constitute an irreversible loss of soil that would be lost in perpetuity.

Irretrievable effects on soils and vegetation would take place at disturbed areas where reclamation is successfully accomplished or only temporary in nature, particularly along rights-of-way. Soils and vegetation in these areas would eventually return to full functionality, possibly within years or decades.

Overview

Any large-scale earthmoving operation, such as mining, will inevitably result in increased machinery-generated noise and vibration above previous ambient levels for a given location. The proposed Resolution Copper Mine differs from many mining operations in that most sounds and vibrations from blasting and ore removal would occur far underground and not be perceptible at the surface. There would, however, be increases in noise and vibration throughout the construction and operational phases of the mine from facility-building activity, haul truck traffic, and employee vehicles moving to and from the mine. The text section below provides a detailed analysis of estimated impacts from noise and vibration under the GPO-proposed mine plan and each of the alternatives.

3.4 Noise and Vibration

3.4.1 Introduction

Development, operation, and reclamation of the mine could result in an increase in noise and vibrations in the immediate vicinity of mine facilities. Activities that could increase noise and vibrations include blasting, underground conveyance of ore, processing operations, operations at the filter plant and loadout facility, and operations at the tailings facilities. Increases in traffic associated with worker commuting, material delivery, and mine product shipment could also contribute to an overall increase in noise on area roads and highways.

Noise and vibration (both blasting and non-blasting related) associated with mining activities would vary spatially and temporally throughout the life of the project, depending on the phase.

This section describes noise and vibrations from blasting and non-blasting activities, during both construction and operation, for each alternative. Additional details not included may be found in the project record (Newell 2018d). Note that noise and vibration impacts on wildlife are addressed in section 3.8.

3.4.2 Analysis Methodology, Assumptions, and Uncertain and Unknown Information

3.4.2.1 Analysis Area

The spatial analysis area consists of the area in which predicted noise and vibration caused by the project attenuate to background levels. The analysis generally evaluated land uses within 2 miles of each mine component, which encompasses the area in which predicted noise would be noticeable. The noise and vibration analysis area is shown in figure 3.4.2-1.

3.4.2.2 Noise Analysis Methodology

The following sections describe the analysis methodology, assumptions, and uncertainties involved in modeling noise and vibration, respectively.

Sensitive Receptors

The noise analysis focuses on noise levels at areas where there are existing or future land uses that are particularly sensitive to noise, known as “noise sensitive areas.” These are as follows:

- Areas potentially affected by noise from the West Plant Site or traffic: Residences in Superior and residences along U.S. 60 and Main Street
- Areas potentially affected by noise from the East Plant Site: Oak Flat Campground and Apache Leap Special Management Area
- Areas potentially affected by noise from the filter plant and loadout facility: Westernstar Road, Lind Road, Felix Road, and Attaway Road
- Areas potentially affected by noise from the Alternative 2 and 3 tailings storage facility: Hewitt Station, residences in Queen Valley,

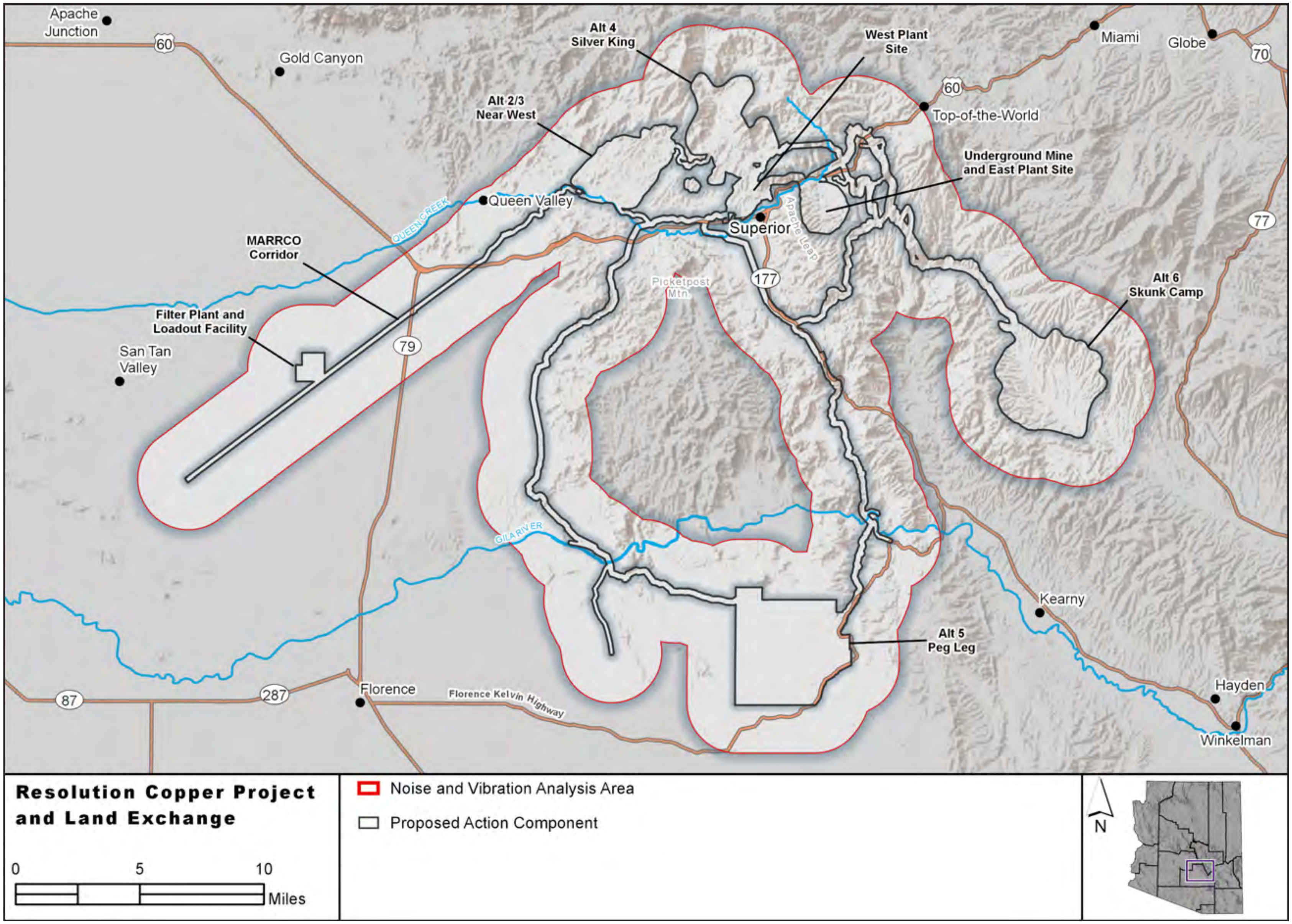


Figure 3.4.2-1. Noise and vibration analysis area

Boyce Thompson Arboretum, and Arizona Trail (northwest of Superior)

- Areas potentially affected by noise from the Alternative 4 tailings storage facility: Arizona Trail (northwest of Superior)
- Areas potentially affected by noise from the Alternative 5 tailings storage facility: Arizona Trail (near Zellweger Wash)
- Areas potentially affected by noise from the Alternative 6 tailings storage facility: Dripping Springs Road and Arizona Trail (near Kelvin)

Within each of these general areas, a specific location was selected for modeling of predicted noise impacts from the project, referred to as a “sensitive receptor.” The specific location of each sensitive receptor was placed where predicted noise levels were expected to be highest for that area; these receptors are described further in section 3.4.3.

Background Noise Measurements

In order to conduct noise modeling, an understanding of background noise levels is required. Background noise levels were measured at five locations, corresponding to the noise sensitive areas described under “Sensitive Receptors.” Note that background noise levels were not collected specifically for the Alternative 6 tailings storage facility but were assumed to be similar to the Alternative 5 tailings storage facility based on the general area and land use.

Background noise levels are monitored for several days or weeks in order to account for variation between day and night, and weekends and weekdays. The background noise data are then reviewed to identify any anomalies, such as fireworks, thunder, rainfall, high wind, or very close activity (like a nearby off-road vehicle). While these types of noises do occur in the analysis area, they happen infrequently or may affect the monitoring equipment more than they would a human listener. The goal of background noise measurements is to obtain a “typical” background level, while acknowledging that occasional louder noises would also occur.

- East Plant Site. Monitored June 7 through 20, 2016.
- West Plant Site. Monitored June 7 through 10, and June 22 through July 5, 2016.
- Alternative 2 and 3 tailings storage facility. Monitored June 7 through 16, and June 20 through July 5, 2016 (summer conditions), and monitored November 15 through 23, and November 28 through December 6, 2017 (winter conditions).
- Filter plant and loadout facility. Monitored June 7 through 16, and June 20 through July 5, 2016.
- Alternative 4 tailings storage facility. Monitored November 14 through 18, 2017, and January 5 through 15, 2018.
- Alternative 5 tailings storage facility (also used for Alternative 6 tailings storage facility). Monitored November 14 through December 27, 2017.

In order to check whether the background noise levels measured in the field were reasonable, they were checked against the expected noise levels based on similar types of land uses, and also checked against several previous studies conducted for the West Plant Site in 2015. These comparisons, which are described in section 3.4.4, are important because they confirm that the background noise measurements are a reasonably accurate estimate of current baseline conditions and because they also verify that background noise from these six monitoring locations can reasonably be used for all 16 sensitive receptors for which project noise levels are predicted.

Construction Phase – Blasting Noise Modeling

Construction activities include the construction of the underground tunnel to convey ore from the underground production area to the West Plant Site. The tunnel construction would use underground drilling and explosives, generating airblast noise (or more technically, peak air overpressure, which is a measure of the pressure wave generated by the blast).

The predictive model for airblast noise is based on information from the U.S. Bureau of Mines (Siskind et al. 1980) and surface mining regulations (30 CFR 816.67). The model predicts the amount of explosive that can be used, given the distance (as measured at a slant through the ground) between an underground source and a sensitive receptor, and given a desired limit on airblast noise.

Construction Phase – Non-Blasting Noise Modeling

Construction activities occur both underground and aboveground. Construction-phase noise modeling focuses on the aboveground construction of the West Plant Site, the filter plant and loadout facility, and the East Plant Site. Each of these has a focused construction period with increased noise levels that would last from 12 to 18 months.

Underground construction of tunnels and infrastructure would continue throughout the operations phase of the project, as would construction of the tailings storage facility. These construction noise impacts are therefore incorporated into the operational modeling.

To model construction noise, different types of equipment were identified that would be used at each site (i.e., dozers, graders, pickup trucks). Typical noise levels from these types of equipment have been documented by the U.S. Environmental Protection Agency (EPA) (Bolt et al. 1971) and Federal Highway Administration (Knauer et al. 2006). The assumption is made that all equipment is running simultaneously at the middle of each construction site, and the spread of sound waves is modeled, without accounting for any shielding effects from topography or structures. Specific construction assumptions include the following:

- West Plant Site. Construction activities occur over an 18-month period, and include improving the main site entrance at Lone Tree Road, improving Silver King Mine Road, and constructing a number of buildings (administration, warehouse, contractor laydown yard, concentrator site, and new substation).
- East Plant Site. Construction activities occur near Shafts 9 and 10 over a 12-month period, and include expansion of the shaft pad and construction of surface infrastructure that supports the underground operations. Shaft construction is analyzed as part of the blasting noise analysis.
- Filter plant and loadout facility. Construction activities occur over an 18-month period, and include construction of the filter plant, and improvements along the MARRCO corridor (rail line, pipelines, wells, pipeline booster station sites, and access points), and improvements along Skyline Drive.

Operations Phase – Non-Blasting Noise Modeling

Noise modeling for the operational phase identifies the quantity and type of equipment in use, the expected sound level from the equipment, and what percentage of the time it would be used. The noise modeling also takes into account noise from project road and rail traffic. In order to avoid underestimating impacts, all equipment is modeled as if it were operating simultaneously and under weather conditions favorable to sound propagation.

The modeling takes into account the combined effect of multiple noise sources, and factors that tend to attenuate sound like reflection from surfaces, screening by topography or obstacles, and terrain effects like elevation.

The noise modeling produces the following results. The metrics listed—Leq(h) and Ldn—are common noise metrics, and detailed explanations are included in Newell (2018d):

- The hourly equivalent sound level, Leq(h), at the location of each sensitive receptor
- The 24-hour day-night average sound level, Ldn, at the location of each sensitive receptor
- Noise contours showing how sound from the project propagates over the surrounding area. Noise contours graphically display how the combined project noise would be distributed over the surrounding area; they are similar to topography elevation

maps. Equal noise levels are represented by continuous lines around a source.

The results shown in this section include the noise predicted from the project, the anticipated future noise range (background noise added to predicted project noise), and the incremental increase in noise over background levels.

3.4.2.3 Vibration Analysis Methodology

Construction Phase – Blasting Vibration Modeling

The construction of the underground tunnel would also generate ground-borne vibrations. The predictive model for blasting vibrations is based on information from the U.S. Bureau of Mines (Nicholls et al. 1971; Siskind et al. 1980) and surface mining regulations (30 CFR 816.67). The predictive model for blast vibrations predicts the amount of explosive that can be used, given the distance between an underground source and a sensitive receptor, and given a desired limit on vibrations.

Background vibration measurements were taken at the same locations as the background noise measurements, at approximately the same time. To provide context, the analysis compares the predicted vibrations to measured background vibrations, and also assesses real-world vibration measurements that were collected during blasting at the East Plant Site in 2018.

Construction and Operations Phase – Non-Blasting Vibration Modeling

Non-blasting vibration occurs from train movement, construction activities, stationary equipment, and other mobile equipment. Ground-borne vibrations were predicted using the type of equipment generally causing the greatest vibrations (an earthmoving truck), using estimates from the Federal Transit Administration (Quagliata et al. 2018).

3.4.3 Affected Environment

3.4.3.1 Relevant Laws, Metrics, Regulations, Policies, and Plans

No single regulatory agency or threshold is applicable to non-blasting noise generated by activities at the project sites. A full discussion of noise thresholds of significance appropriate for mining activities can be found elsewhere (Newell 2018d).

Primary Legal Authorities Relevant to the Noise Effects Analysis

- U.S. Department of Housing and Urban Development standards
- Pinal County Excessive Noise Ordinance
- Federal Highway Administration and Arizona Department of Transportation (ADOT) standards
- Office of Surface Mining Reclamation and Enforcement
- Federal Transit Administration
- Occupational Safety and Health Administration
- Mine Safety and Health Administration

3.4.3.2 Selected Thresholds

A variety of thresholds are used to put the predicted noise and vibration modeling results in context. These thresholds are being used for the purposes of the NEPA analysis. Note that these thresholds are likely not applicable to the project in a legal or regulatory sense, and in many cases have very specific applications or specific limitations that are not included explicitly in this analysis.

Blasting Noise Thresholds (Peak Air Overpressure)

The selected threshold for airblast level is at or below 120 unweighted decibels (dBL), which is based on results presented in U.S. Bureau of Mines RI 8485 (Siskind et al. 1980) and represents a reasonable maximum threshold to avoid impacts on structures and humans.

Non-Blasting Noise Thresholds

Thresholds of interest for non-blasting noise include the following:

- For the Ldn metric, the selected threshold is 65 A-weighted decibels (dBA). This is based on the U.S. Department of Housing and Urban Development's Acceptability Standards.
- For the Leq(h) metric, the selected threshold is 55 dBA. This is based on the Pinal County Excessive Noise Ordinance for residential areas during nighttime hours.
- For the Leq(h) metric, an additional selected threshold is 66 dBA. This is based on the ADOT Noise Abatement Criteria for external noise at residential areas (activity class "B").
- An additional threshold applied to all metrics is the incremental increase in noise over background, with a threshold of 15 dBA. This is based on the ADOT substantial noise increase criteria.

Blasting Vibration Thresholds

The selected threshold for ground-borne vibrations is 0.1884 inches per second, peak particle velocity (PPV in/sec.), which is below the human tolerable threshold of 0.5 PPV in/sec., and represents a worst-case threshold. The selected value is also considered reasonable because blasting activities at the mine site are proposed at significant depths, primarily resulting in low-frequency components. However, once blasting commences and vibration monitoring is conducted, if blasting is found to mostly generate frequencies above 3 hertz (i.e., corresponding to high frequency), the selected threshold could increase to 0.5 PPV in/sec.

Non-Blasting-Vibration Thresholds

The selected threshold is at or below 0.04 PPV in/sec. (80 vibration decibels [VdB]), which is based upon results presented in Federal Transit Administration 2018 guidelines (Quagliata et al. 2018).

3.4.3.3 Existing Conditions and Ongoing Trends

The information presented in the following subsections are presented in more detail in the report titled "Sound and Vibration Analysis Report" (Tetra Tech Inc. 2019) and the memorandum titled "Blasting Monitoring Review Memorandum" (Rodrigues 2018).

Land Use and Sensitive Receptor Identification

Land uses within 2 miles of each mine component (i.e., West Plant Site, East Plant Site, filter plant and loadout facility, MARRCO corridor, tailings storage facility alternatives) were grouped and categorized into three main land uses: (1) residential, (2) commercial, and (3) recreation/conservation. Sensitive receptors were then identified and are shown on figure 3.4.3-1.

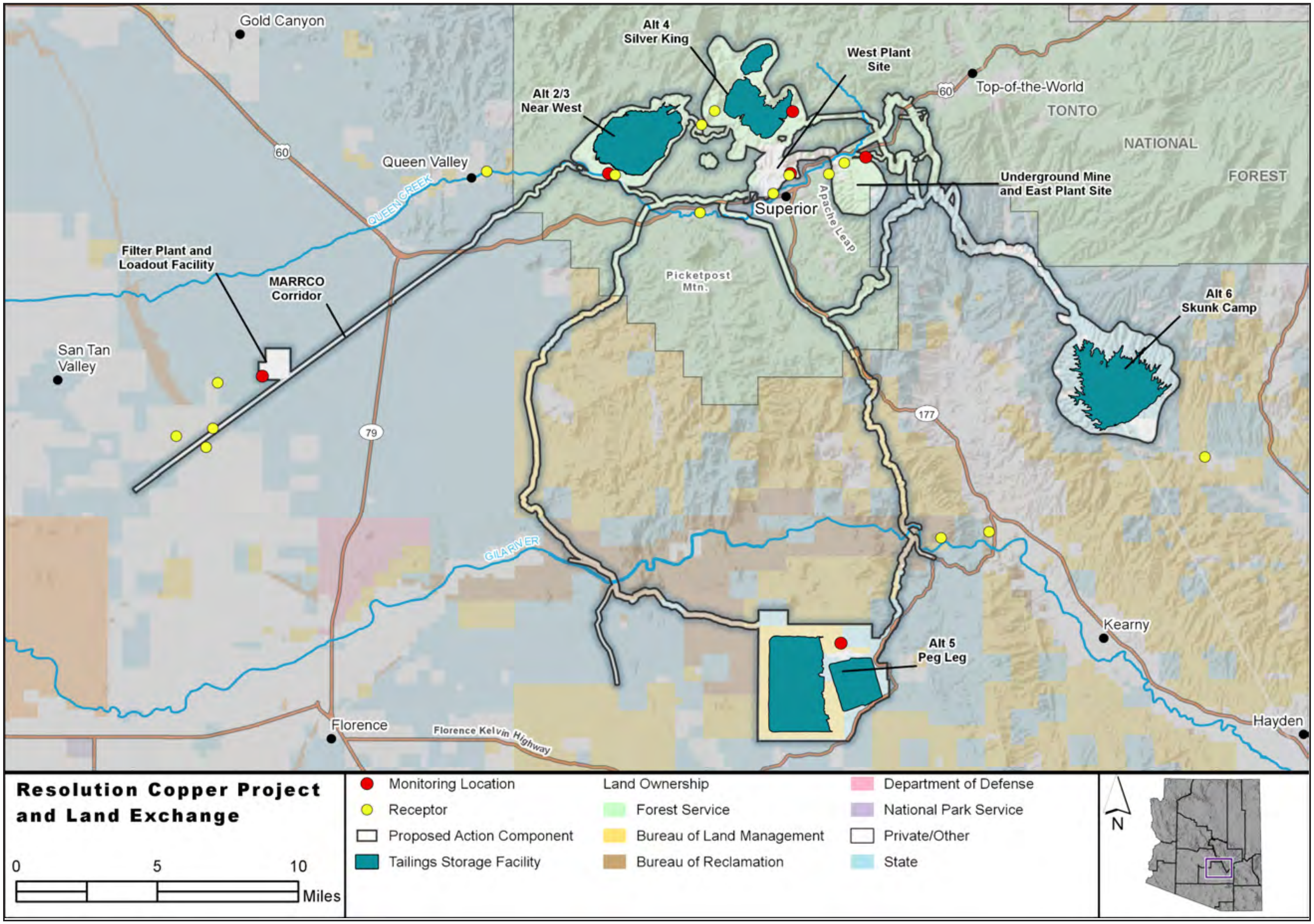


Figure 3.4.3-1. Land use, sensitive areas/receptors identification, and measurement locations

Background Measurement Locations and Descriptions

Background noise and vibration measurements were conducted during two periods, representing the acoustical environment during the spring/summer months (i.e., fewer residents and less outdoor recreation) and fall/winter months (i.e., more residents and more outdoor recreation). The following briefly describes the measurement locations:

- East Plant Site measurement: placed near the edge of the East Plant Site, approximately 650 feet from the existing Shaft 10 and 0.8 mile from the Oak Flat Campground and U.S. 60 route. Nearby land uses include recreation/conservation uses and two sensitive receptors (Oak Flat Campground and the Apache Leap Special Management Area). Noise anomalies removed from the data set included rainfall, thunder, and operation of the existing East Plant Site. These were removed because the East Plant Site noise expected to occur during operations is part of the predicted modeling, not part of the background.
- West Plant Site measurement: placed near the West Plant Site facility property line and adjacent to the town of Superior (incorporated county land), where the nearest residential property line is approximately 260 feet to the south. Land uses within a 2-mile radius include residential, commercial, and recreation/conservation use. Nearby land use represented at this location is residential and includes one sensitive receptor (residences in the town of Superior). Noise anomalies removed from the data set included rainfall, thunder, fireworks, and operation of the existing West Plant Site. These were removed because the West Plant Site noise expected to occur during operations is part of the predicted modeling, not part of the background.
- Near West tailings storage facility measurement: placed on private land, a residential property at 32898 Hewitt Station Road, within the Tonto National Forest, approximately 1,000 feet from the edge of the proposed Near West tailings storage facility. To avoid data contamination from residential activities, the monitoring location was 550 feet from the residence. Nearby land uses include residential and recreation/conservation uses and four sensitive receptors (Hewitt Station, the section of the Arizona Trail near the Near West tailings storage facility, residences in Queen Valley, and Boyce Thompson Arboretum). Noise anomalies removed from the data set included rainfall, thunder, and limited activities of all-terrain vehicles (ATVs) during the summer months and excessive wind, noise from the ranch, rainfall, and ATVs during the winter months.
- Filter plant and loadout facility measurement: placed at the proposed facility location, where the nearest residential property line is approximately 1.6 miles to the west along Skyline Drive. Nearby land uses include residential near Westernstar Road, Lind Road, Felix Road, and Attaway Road. Noise anomalies removed from the data set included rainfall and thunder. Because this location is isolated from any significant noise source, there were no identified primary noise sources.
- Silver King tailings storage facility measurement: placed at the proposed facility location. Nearby land uses include residential and recreation/conservation uses and one sensitive receptor (a section of the Arizona Trail located 2 miles to the west). Noise anomalies removed from the data set included excessive wind and light rainfall. Because this location is isolated from any significant noise source, there were no identified primary noise sources.
- Peg Leg tailings storage facility measurement: placed at the proposed facility location. Nearby land uses include recreation/conservation uses and one sensitive receptor (a section of the Arizona Trail located 2.4 miles to the east). Noise anomalies removed from the data set included excessive wind. Although this location was near a substation, the monitor placement was far enough from the substation to avoid data contamination. Because this location is isolated from any significant noise source, there were no identified primary noise sources. This location also serves as the source of background noise for

Alternative 6, given the similar rural setting. Future background noise measurements may be collected at Alternative 6 if substantial differences are identified in background noise levels.

Interpretation of Background "Ambient" Noise Measurements

Noise levels within the analysis area showed relatively low levels and exhibited typical diurnal patterns. The predominant source in the measured adjusted noise levels (i.e., after removal of identified anomalies) at each of the measurement locations were (1) for the East Plant Site: wildlife and vehicle traffic from Magma Mine Road and U.S. 60, (2) for the West Plant Site: wildlife and community sources from the town of Superior, (3) for the Near West tailings storage facility: operations from nearby ranches, light vehicle traffic on local roadways, and wildlife, (4) for the filter plant and loadout facility: wildlife and aircraft overflights, (5) for the Silver King tailings storage facility: wildlife and light traffic from campers, and (6) for the Peg Leg tailings storage facility: wildlife and aircraft overflights.

In general, the measured adjusted noise levels were within the expected ranges for the given land use, except for the East Plant Site measurement location, where measured levels were approximately 5 to 10 decibels (dB) higher than expected ranges. However, the higher measured data (i.e., 5–10 dB) is reasonable because the expected range assumes an isolated location and does not consider any influence from the nearby U.S. 60 route. Table 3.4.3-1 summarizes the project sites and associated sensitive receptors, land uses, and expected and measured noise level ranges.

Interpretation of West Plant Site Previous Study Noise Measurements

ARCADIS Inc. conducted two noise studies along the West Plant Site property line adjacent to the town of Superior. The first study, "West Plant Noise Monitoring Study" (ARCADIS U.S. Inc. 2015b), included three measurement locations and collected noise data from May 7 through 15, 2015. Of the three locations, one was placed similar to the West Plant Site measurement location discussed earlier in this section and shown on figure 3.4.3-1. The study found that noise levels at this location ranged from 39 to 65 dBA, Leq(h); however, 65 dBA was noted as an anomaly where noise levels typically ranged between 40 to 50 dBA Leq(h).

The second study, titled "Lower Smelter Pond Noise Monitoring Report Superior, Arizona" (ARCADIS U.S. Inc. 2015a), included four measurement locations and collected noise data from August 18 to September 17, 2015. Three measurement locations were along the West Plant Site southern property line and one was within the residential area near the lower smelter pond. The study found that noise levels at these locations were as high as 75 to 80 dBA, Leq(h) during sludge removal activities, but noise levels typically ranged from 31 to 50 dBA Leq(h).

Noise levels from ARCADIS Inc. studies further confirm that the background noise levels at the West Plant site (39–47 dBA daytime, 33–47 dBA nighttime) are reasonably accurate and representative of adjacent residences in the town of Superior.

Interpretation of Project Area Background "Ambient" Vibration Measurements

The vibration levels at the measurement location were at levels that could be perceived by humans (table 3.4.3-2), but considerably below the U.S. Bureau of Mines RI 8507 threshold of 0.5 PPV in/sec., which is tolerable by 95 percent of humans for an event occurring in a 1-second duration. Based on the maximum values, vibration levels recorded were highest at the West Plant Site—0.07 PPV in/sec. (85 VdB)—which exceeds the Federal Transit Administration's threshold for residential annoyance of 0.04 PPV in/sec. (80 VdB). Average values for vibration levels did not exceed any thresholds of interest.

Table 3.4.3-1. Background measured noise levels and expected ranges for sensitive receptors based on land use

Project Site	Sensitive Receptors	Land Use Type	Data Source	Sound Level (dBA)		
				Ldn	Daytime Leq(h)	Nighttime Leq(h)
West Plant Site	***Noise Measurement Location***		***Measured***	***43–53***	***39–47***	***33–47***
	Residences in Superior	Residential and Commercial	Expected	48–54	48–54	38–44
	Residences between U.S. 60 and Main Street	Residential and Commercial	Expected	48–54	48–54	38–44
East Plant Site	***Noise Measurement Location***		***Measured***	***52–54***	***45–50***	***45–48***
	Oak Flat Campground	Recreation/Conservation	Expected	41–44	41–45	31–33
	Apache Leap Special Management Area	Residential/Recreation/Conservation	Expected	41– 54	41–54	31–44
Near West tailings storage facility	***Noise Measurement Location***		***Measured***	***40–46***	***36–43***	***32–39***
	Hewitt Station	Residential	Expected	35–45	35–45	31–33
	Queen Valley	Residential	Expected	36–42	36–42	26–32
	Boyce Thompson Arboretum	Recreation/Conservation	Expected	41–44	41–45	31–33
	Arizona Trail (northwest of Superior)	Recreation/Conservation	Expected	33–35	32–37	25–30
Filter plant and loadout facility	***Noise Measurement Location***		***Measured***	***38–48***	***38–45***	***27–41***
	Westernstar Road	Residential	Expected	36–45	35–45	28–35
	Lind Road	Residential	Expected	36–45	35–45	28–35
	Felix Road	Residential	Expected	36–45	35–45	28–35
	Attaway Road	Residential	Expected	36–45	35–45	28–35
Silver King tailings storage facility	***Noise Measurement Location***		***Measured***	***35–46***	***31–41***	***27–39***
	Arizona Trail (northwest of Superior)	Recreation/Conservation	Expected	33–35	32–37	25–30
Peg Leg tailings storage facility (measured) and Skunk Camp tailings storage facility (assumed)	***Noise Measurement Location***		***Measured***	***34–52***	***30–51***	***26–46***
	Arizona Trail (near Zellweger Wash)	Recreation/Conservation	Expected	33–35	32–37	25–30

Note: Noise measurements were collected as described below:

West Plant Site: June 7–10, 2016, and June 22–July 5, 2016

East Plant Site: June 7–20, 2016

Near West tailings storage facility: June 7–16, 2016, June 20–July 5, 2016, November 15–23, 2017, and November 28–December 6, 2017

Filter plant and loadout facility: June 7–16, 2016, and June 20–July 5, 2016

Silver King tailings storage facility: November 14–18, 2017, and January 5–15, 2018

Peg Leg tailings storage facility: November 14–December 27, 2017

Table 3.4.3-2. Background vibration measurement summary

Project Site	Measurement Period	Average PPV, in/sec.	Maximum PPV, in/sec.	Maximum VdB
West Plant Site	June 7–July 5, 2016	0.0034	**0.0723**	**85**
East Plant Site	June 7–July 5, 2016	0.0031	0.013	70
Near West tailings storage facility	June 7–July 5, 2016	0.0035	0.0164	72
Filter plant and loadout facility	June 7–July 5, 2016	0.0077	0.0186	73
Silver King tailings storage facility	November 15–December 12, 2017	0.0033	0.0048	62
Peg Leg tailings storage facility	November 15–December 12, 2017	0.0057	0.0175	73

Notes:
VdB = calculated vibration decibel using a vibration reference of 10−6 in/sec. and a crest factor of 4 (i.e., representing a difference of 12 VdB).
Shaded cells indicate an exceedance of a selected threshold by background measurements.

Interpretation of East Plant Site Additional Noise and Vibration Measurements

In January 2018, blasting activities commenced at the East Plant Site 4,000 level (i.e., 4,000 feet below surface) and occurred periodically between January 30 and March 19, 2018. Blasting time histories indicate that 29 blasting activities took place during this period, during both daytime and nighttime hours. Noise and vibration data from blasting events were continuously monitored and recorded. Each event incorporated an average loading of 225 pounds of explosives distributed in a patterned hole system consisting of approximately 50 to 60 holes. The blasting monitoring data show that vibration levels from blasting activities were not distinguishable from background ground-vibration levels.

Table 3.4.3-3. East Plant Site noise data comparison (with blasting and no-blasting activities)

Noise Level Ranges for Each Measurement Period								
Ldn, dBA	Daytime Leq(h), dBA				Nighttime Leq(h), dBA			
	Leq	L10	L90	Lmax	Leq	L10	L90	Lmax
Measurement Period (June 7–20, 2016)								
51.9–54.2	45.2–49.7	47.5–52.2	43.7–46.8	52.1–60.3	45.3–47.7	47.6–50.1	44.3–46.4	49.9–57.9
Measurement Period (January 30–March 19, 2018)								
48.5–58.5	44.1–55.4	48.7–62.3	41.6–53.3	52.5–65.9	41.5–51.2	46.3–56.6	40.3–49.8	48.6–62.8

Notes:
Ldn = Day-night average noise level, a 24-hour average with annoyance penalty of 10 dBA for nighttime noise levels.
Daytime Leq(h) = Equivalent sound level for period between 7:00 a.m. and 10:00 p.m.
Nighttime Leq(h) = Equivalent sound level for period between 10:00 p.m. and 7:00 a.m.
L10 = sound level was exceeded 10 percent of the time (overall monitoring period).
L90 = sound level was exceeded 90 percent of the time (overall monitoring period).
Lmax = Maximum sound level recorded during the measurement period.

To determine whether the blasting events influenced background noise levels, the noise data set from January/March 2018 (which included blasting events) was compared with the noise data set from June 2016 (which did not include any blasting events and was used to establish the background acoustic environment). Table 3.4.3-3 presents a summary of noise monitoring data collected during the 2016 and 2018 periods.

The two data sets are comparable overall for most metrics. The 2018 noise data exhibited a wider range, with the minimum values generally lower than the 2016 background measurements, and the maximum values generally higher than the 2016 background measurements. The L10 (noise level exceeded 10 percent of the time) and Lmax (maximum sound level) metrics are both widely used to describe noise from intermittent or individual events, though very short individual events (like blasting) are unlikely to show up in the L10 values. The 2018 daytime L10 and Lmax metrics had a wide range but were overall higher

than the 2016 background noise measurements, suggesting blasting noise may have been detected. However, a direct comparison of noise levels (collected every second) immediately before, during, and after each blasting event does not show any clear effects (Tetra Tech Inc. 2019).

3.4.4 Environmental Consequences of Implementation of the Proposed Mine Plan and Alternatives

Direct impacts from noise and vibration during construction and operational phases have been modeled for the project (AMEC Foster Wheeler Environment and Infrastructure 2017; Rodrigues 2018; Tetra Tech Inc. 2019).

3.4.4.1 Alternative 1 – No Action

As detected in the 2016 background noise measurements, certain noise-producing activities are currently taking place on Resolution Copper private property at the West Plant Site and East Plant Site. Under the no action alternative, these activities would continue. Noise and vibration levels do not rise above any selected thresholds under background conditions

3.4.4.2 Impacts Common to All Action Alternatives

Effects of Land Exchange

The selected Oak Flat Federal Parcel would leave Forest Service jurisdiction. The role of the Tonto National Forest under its primary authorities in the Organic Administration Act, Locatable Regulations (36 CFR 228 Subpart A), and Multiple-Use Mining Act is to ensure that mining activities minimize adverse environmental effects on National Forest System surface resources; this includes effects on the natural setting from noise that could occur on the Oak Flat Federal Parcel. The Oak Flat Federal Parcel would become private at the completion of the NEPA process, and the Forest Service would not have the ability to require mitigation for effects from noise on the lands; however, no adverse noise effects were identified to occur from the East Plant Site operations.

The offered parcels would come under Federal jurisdiction. Specific management of the natural setting of those parcels would be determined by the agencies to meet desired conditions or support appropriate land uses and would include noise considerations.

Effects of Forest Plan Amendment

The Tonto National Forest Land and Resource Management Plan (1985b) provides guidance for management of lands and activities within the Tonto National Forest. It accomplishes this by establishing a mission, goals, objectives, and standards and guidelines. Missions, goals, and objectives are applicable on a forest-wide basis. Standards and guidelines are either applicable on a forest-wide basis or by specific management area.

A review of all components of the 1985 forest plan was conducted to identify the need for amendment due to the effects of the project, including both the land exchange and the proposed mine plan (Shin 2019). No standards and guidelines were identified applicable to noise or vibration. For additional details on specific rationale, see Shin (2019).

Summary of Applicant-Committed Environmental Protection Measures

A number of environmental protection measures are incorporated into the design of the project that would act to reduce potential impacts on noise and vibration. These are non-discretionary measures and their effects are accounted for in the analysis of environmental consequences.

The GPO (2016d) outlined applicant-committed environmental protection measures by Resolution Copper in the “Environmental Protection Elements” section.

- Mining activities, primary crushing and conveying, will take place underground, and exhaust fans will be equipped with silencers for noise reduction. Milling will take place within a fully enclosed building.

3.4.4.3 Alternatives 2 and 3 – Near West – Modified Proposed Action

Construction Phase – Blasting Noise and Vibration Impacts

In order to analyze ground-borne vibrations associated with construction of the underground tunnel, 10 structures in the town of Superior were selected as representative samples based on the shortest slant distance to the tunnel. Sections of the tunnel would also run along the Apache Leap SMA sensitive receptor, where the shortest slant distance is approximately 1,536 feet (near the westerly side) and 3,506 feet (near the easterly side) (figure 3.4.4-1).

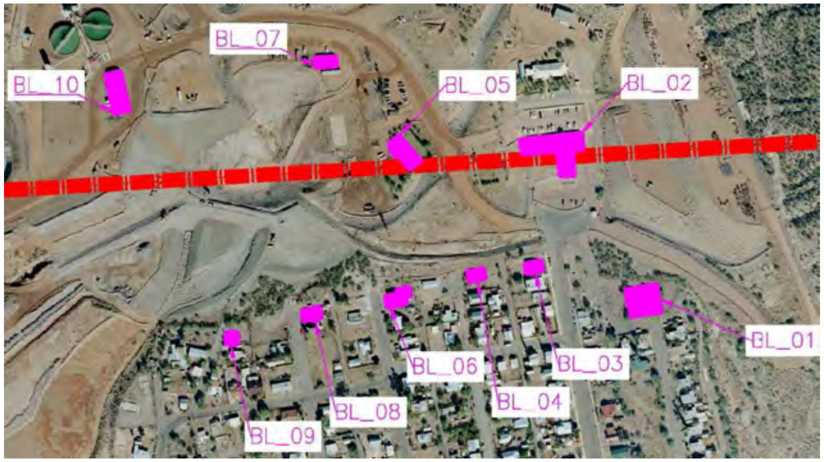


Figure 3.4.4-1. Locations of buildings analyzed for selected vibration threshold near West Plant Site and underground tunnel

Table 3.4.4-1. Calculated explosive loading at sensitive receptor samples based on selected vibration threshold

Sensitive Receptor	Slant Distance (feet)	**Allowable Explosive Load per Delay (kg TNTe)**
BL_1	1,235	24
BL_2 (*located on West Plant Site facility property*)	864	12
BL_3	1,114	19
BL_4	1,061	18
BL_5 (*located on West Plant Site facility property*)	758	9
BL_6	1,101	19
BL_7 (*located on West Plant Site facility property*)	1,023	16
BL_8	1,135	20
BL_9	1,210	23
BL_10 (*located on West Plant Site facility property*)	775	9
Apache Leap SMA	1,535	37

Note: Calculated allowable explosive load per delay is based on 0.1884 PPV in/sec. vibration threshold.

The explosive load per delay presented in table 3.4.4-1 are calculated based on the selected vibration threshold, sensitive receptor locations, tunnel alignment, and profile data. At the nearest sensitive receptor (BL_5), located on the West Plant Site facility property, the blast loading should be kept below 9 kilograms TNT equivalent (kg TNTe) per delay. Impacts on the Apache Leap SMA could also be limited by keeping the blast loading below 37 kg TNTe/delay.

Airblast impacts could be more notable near the vent raise and portal openings; analysis for these areas is shown in table 3.4.4-2. The vent raise location is approximately 1,600 feet and the portal opening is approximately 2,792 feet from the closest sensitive receptor (identified

Table 3.4.4-2. Calculated explosive loading at sensitive receptor samples based on airblast selected threshold

Source Location	Sensitive Receptor	Slant Distance (feet)	Allowable Explosive Load per Delay (kg TNTe)	Estimated Results	
				Airblast Level, dBL	PPV in/ sec.
Vent raise	BL_10	1,600	35	118	0.170
	Apache Leap SMA	5,981	380	114	0.157
Portal opening	BL_10	2,792	120	118	0.186

as BL_10). The vent raise location is also approximately 5,981 feet from the westerly side of the Apache Leap SMA boundary. Blasting loading should be kept below 35 kg TNTe at the vent raise and 120 kg TNTe at the portal opening.

The exact blasting plan for the tunnel would depend on conditions encountered during construction and has not yet been developed; explosive loads kept under these limits are not anticipated to result in adverse impacts from vibration.

Construction Phase – Non-Blasting Noise Impacts

Table 3.4.4-4, later in this section, shows noise level estimates from the construction of the operational facilities would range from 89 dBA at 50 feet to 63 dBA at 1,000 feet. Construction activities would occur for 10 hours during daytime weekday shifts. The most appropriate noise threshold for daytime activities is the Leq(h) of 66 dBA, based on ADOT residential criteria. Past 1,000 feet, noise levels do not exceed this threshold. The overall levels should be lower, because (as discussed in section 3.4.2) these estimates exclude attenuation factors and trend toward quieter construction equipment since the source data were developed. Beyond 1,000 feet, construction noise is not anticipated to result in adverse impacts.

Operations Phase – Non-Blasting Noise Impacts

Table 3.4.4-5, later in this section, shows that noise impacts in Leq(h) metric are not expected to occur based on the predicted minimum and average noise level ranges, whether looking at overall combined noise levels (project noise plus background noise), or the incremental noise increase over background levels.

If the maximum of each range is used, incremental increases are at or above the selected threshold of 15 dBA at following sensitive receptors:

- Residential receptors near U.S. 60 and Main Street.
- Recreational users within Apache Leap SMA.
- Recreational users of nearby section of the Arizona Trail.

Residential receptors near U.S. 60 and Main Street would also experience future levels (project noise plus background noise) above 55 dBA (Pinal County nighttime noise threshold limit), but below 66 dBA (ADOT's modified Noise Abatement Criteria "B" for residential uses). Because residential receptors near U.S. 60 and Main Street are within incorporated lands in the town of Superior, ADOT's modified Noise Abatement Criteria would be more applicable.

Table 3.4.4-6, later in this section, shows that predicted future noise levels in Ldn metric would comply with the selected threshold of 65 Ldn. Nearby sections of the Arizona Trail would experience increases in noise above the incremental threshold of 15 dBA, but only under maximum conditions. The maximum condition assumes all equipment operating simultaneously during the quietest period; this would be an infrequent and unlikely occurrence. Figures 3.4.4-2 and 3.4.4-3 show the predicted noise contours propagation over the surrounding area of the mine site associated with the Alternatives 2 and 3.

Table 3.4.4-3. Predicted non-blasting vibration impacts during operations, Alternatives 2 and 3

Feet from Source	Calculated Non-Blasting Vibration Levels	
	PPV in/sec.	VdB
25	**0.0890**	**87**
50	0.0315	78
75	0.0171	73
100	0.0111	69
125	0.0080	66
150	0.0061	64
175	0.0048	62
200	0.0039	60
225	0.0033	58
250	0.0028	57
275	0.0024	56
300	0.0021	55

Shaded cells indicate an exceedance of selected threshold of 0.04 PPV in/sec (80 VdB).

OPERATIONS PHASE – NON-BLASTING VIBRATION IMPACTS

Table 3.4.4-3 shows that ground-borne vibration PPV in/sec. are not expected to exceed the selected threshold of 0.04 PPV in/sec. (80 VdB) at 50 feet or more from the source. The calculated vibration levels in 25-foot increments from the source show 0.0315 PPV in/sec. (78 VdB) at 50 feet, which is less than the selected threshold.

Beyond 50 feet, vibration during operations is not anticipated to result in adverse impacts.

3.4.4.4 Alternative 4 – Silver King

Alternative 4 would have identical impacts on Alternatives 2 and 3 for construction blasting noise, construction blasting vibration, construction non-blasting noise, and operations non-blasting vibration. Only operational noise impacts would differ and are described here.

Similar to Alternatives 2 and 3, table 3.4.4-7 shows that noise impacts in Leq(h) metric are not expected to occur based on the predicted minimum and average noise level (whether looking at overall combined noise levels [project noise plus background noise], or the incremental noise increase over background levels). If the maximum of each range is used, incremental increases are at or above the selected threshold of 15 dBA at the following receptors:

- Residential receptors near U.S. 60 and Main Street.
- Recreational users within Apache Leap SMA.

The maximum condition assumes all equipment operating simultaneously during the quietest period; this would be an infrequent and unlikely occurrence.

Residential receptors near U.S. 60 and Main Street would also experience future levels above 55 dBA, but below 66 dBA, based on maximum values. Table 3.4.4-8 shows that predicted future noise levels in Ldn metric would comply with all the selected thresholds. Figure 3.4.4-4 shows the predicted noise contours for Alternative 4.

Table 3.4.4-4. Estimated noise levels from construction activities

Sound Source	Quantity: West Plant Site	Quantity: East Plant Site	Quantity: Filter Plant and Loadout Facility	Utilization Factor: %	dBA Leq(h)*: 50	dBA Leq(h)*: 100	dBA Leq(h)*: 250	dBA Leq(h)*: 500	dBA Leq(h)*: 1,000
Dozer	6	5	1	40	**81**	**75**	**67**	61	55
Grader	3	3	1	40	**81**	**75**	**67**	61	55
Compactor	2	2	1	20	**73**	**67**	59	53	47
Scraper	3	3	1	40	**81**	**75**	**67**	61	55
Water truck	2	1	1	40	**80**	**74**	66	60	54
Fuel/lube truck	1	1	1	40	**80**	**74**	66	60	54
Excavator	2	2	1	40	**81**	**75**	**67**	61	55
Loader	1	1	0	40	**86**	**70**	62	56	50
Haul truck	1	1	0	40	**80**	**74**	66	60	54
Pickup truck	3	3	0	40	51	45	37	31	25
Combined Noise Levels					**89**	**83**	**75**	**69**	**63**

Source: Tetra Tech (2018)
Note: Shaded cells indicate an exceedance of selected threshold of 66 dBA
* Calculations assume only one sound source is in operation

Table 3.4.4-5. Predicted noise impacts during operations, Alternatives 2 and 3, Leq(h) metric

Project Site	Sensitive Receptors	Project Predicted Levels	Future Levels, dBA: Project plus Background Levels Min	Avg	Max	Increase Over Background Levels Min	Avg	Max
West Plant Site	***Noise Measurement Location****	***47***	***47***	***49***	***50***	***3***	***5***	***14***
	Residences in Superior	47	47	49	50	3	5	14
	Residences U.S. 60 and Main Street†	53	53	55	**57**	3	4	15
East Plant Site	***Noise Measurement Location****	***61***	***61***	***61***	***61***	***11***	***12***	***16***
	Oak Flat Campground‡	43	43	49	51	1	1	12
	Apache Leap SMA‡	46	46	50	51	1	2	15
Near West tailings storage facility	***Noise Measurement Location****	***43***	***43***	***45***	***46***	***3***	***4***	***11***
	Hewitt Station	44	44	46	47	4	5	12
	Residences in Queen Valley‡	<10	26	40	43	<1	<1	<1
	Boyce Thompson Arboretum	24	33	41	43	<1	<1	1
	Arizona Trail (northwest of Superior)‡	51	51	51	52	9	11	**26**
Filter plant and loadout facility/ MARRCO corridor	***Noise Measurement Location****	***47***	***47***	***48***	***49***	***4***	***6***	***20***
	Westernstar Road	<10	27	42	45	<1	<1	<1
	Lind Road	32	33	43	45	<1	<1	6
	Felix Road	26	30	42	45	<1	<1	3
	Attaway Road	13	27	42	45	<1	<1	<1

Note: Shaded cells indicate an exceedance at a sensitive receptor of selected threshold of 55 dBA for project plus background levels, and 15 dBA for increase over background levels.
Min = Minimum, Avg = Average, Max = Maximum
* Prediction location is not a sensitive receptor and included for comparison to the existing measured noise levels (see table 3.4.3-1).
† Lower and upper levels are based on the expected sound levels due to the vicinity of the highway (see table 3.4.3-1).
‡ The expected lower level was applied to be conservative (see table 3.4.3-1).

Table 3.4.4-6. Predicted noise impacts during operations, Alternatives 2 and 3, Ldn metric

Project Site	Sensitive Receptors	Future Levels, dBA						
		Project Predicted Levels	Project plus Background Levels			Increase Over Background Levels		
			Min	Avg	Max	Min	Avg	Max
West Plant Site	***Noise Measurement Location****	***54***	***54***	***56***	***57***	***4***	***5***	***11***
	Residences in Superior	54	54	56	57	4	5	11
	Residences U.S. 60 and Main Street†	59	59	60	60	6	7	11
East Plant Site	*Noise Measurement Location**	***67***	***67***	***67***	***67***	***13***	***16***	***26***
	Oak Flat Campground‡	50	51	54	55	1	2	10
	Apache Leap SMA‡	52	55	56	56	2	2	4
Near West tailings storage facility	***Noise Measurement Location****	***48***	***49***	***50***	***50***	***4***	***5***	***9***
	Hewitt Station	50	50	51	51	5	6	10
	Residences in Queen Valley‡	<10	36	44	46	<1	<1	<1
	Boyce Thompson Arboretum	31	41	45	46	<1	<1	1
	Arizona Trail (northwest of Superior)‡	58	58	58	58	12	15	25
Filter plant and loadout facility/ MARRCO corridor	***Noise Measurement Location****	***53***	***53***	***54***	***54***	***6***	***8***	***15***
	Westernstar Road	<10	38	46	48	<1	<1	<1
	Lind Road	30	39	46	48	<1	<1	1
	Felix Road	24	38	46	48	<1	<1	<1
	Attaway Road	11	38	46	48	<1	<1	<1

Note: Shaded cells indicate an exceedance at a sensitive receptor of selected threshold of 65 dBA for project plus background levels, and 15 dBA for increase over background levels.
Min = Minimum, Avg = Average, Max = Maximum
* Prediction location is not a sensitive receptor and included for comparison to the existing measured noise levels (see table 3.4.3-1).
† Lower and upper levels are based on the expected sound levels due to the vicinity of the highway (see table 3.4.3-1).
‡ The expected lower level was applied to be conservative (see table 3.4.3-1).

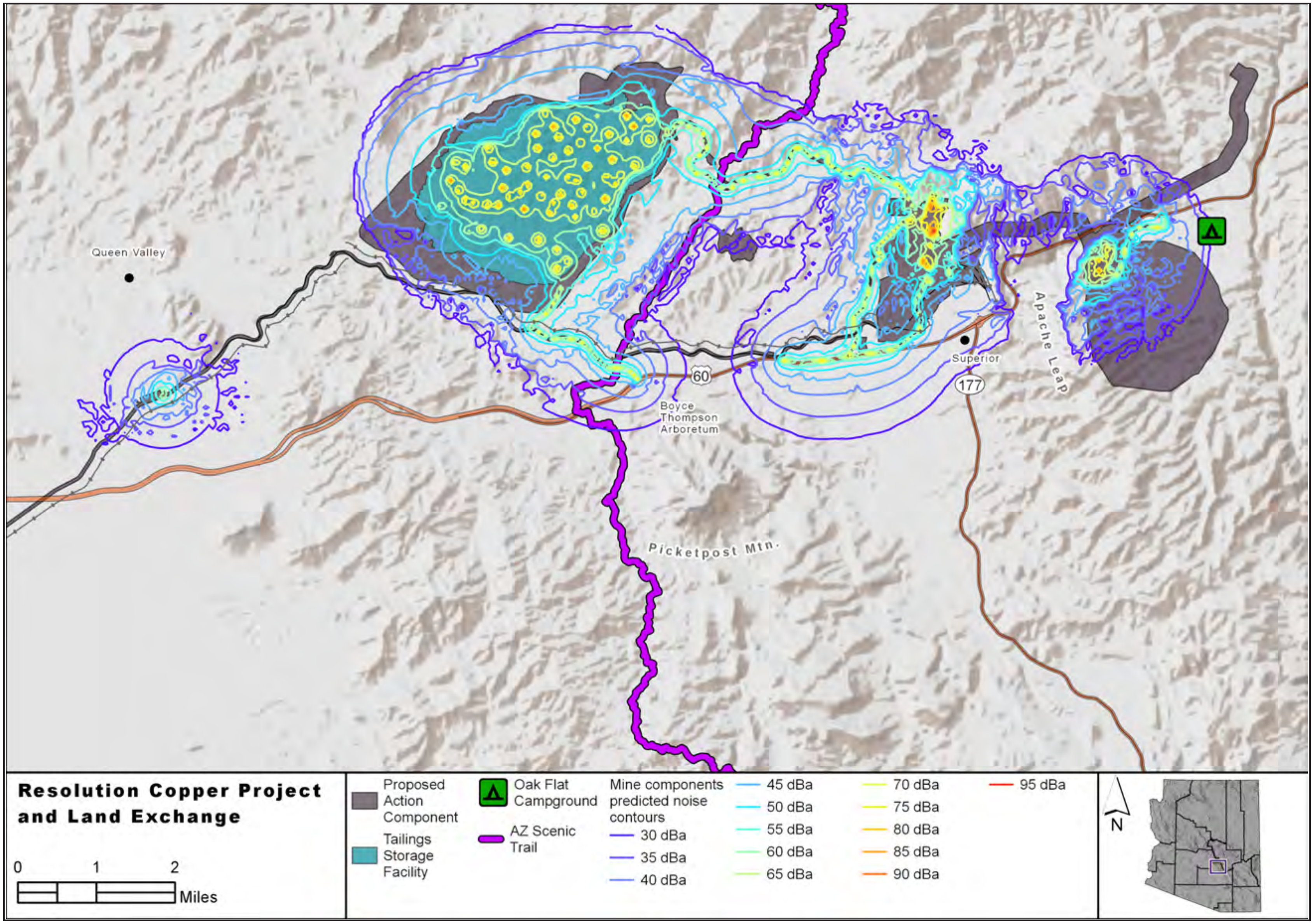


Figure 3.4.4-2. Predicted noise contours associated with Alternatives 2 and 3 (1 of 2)

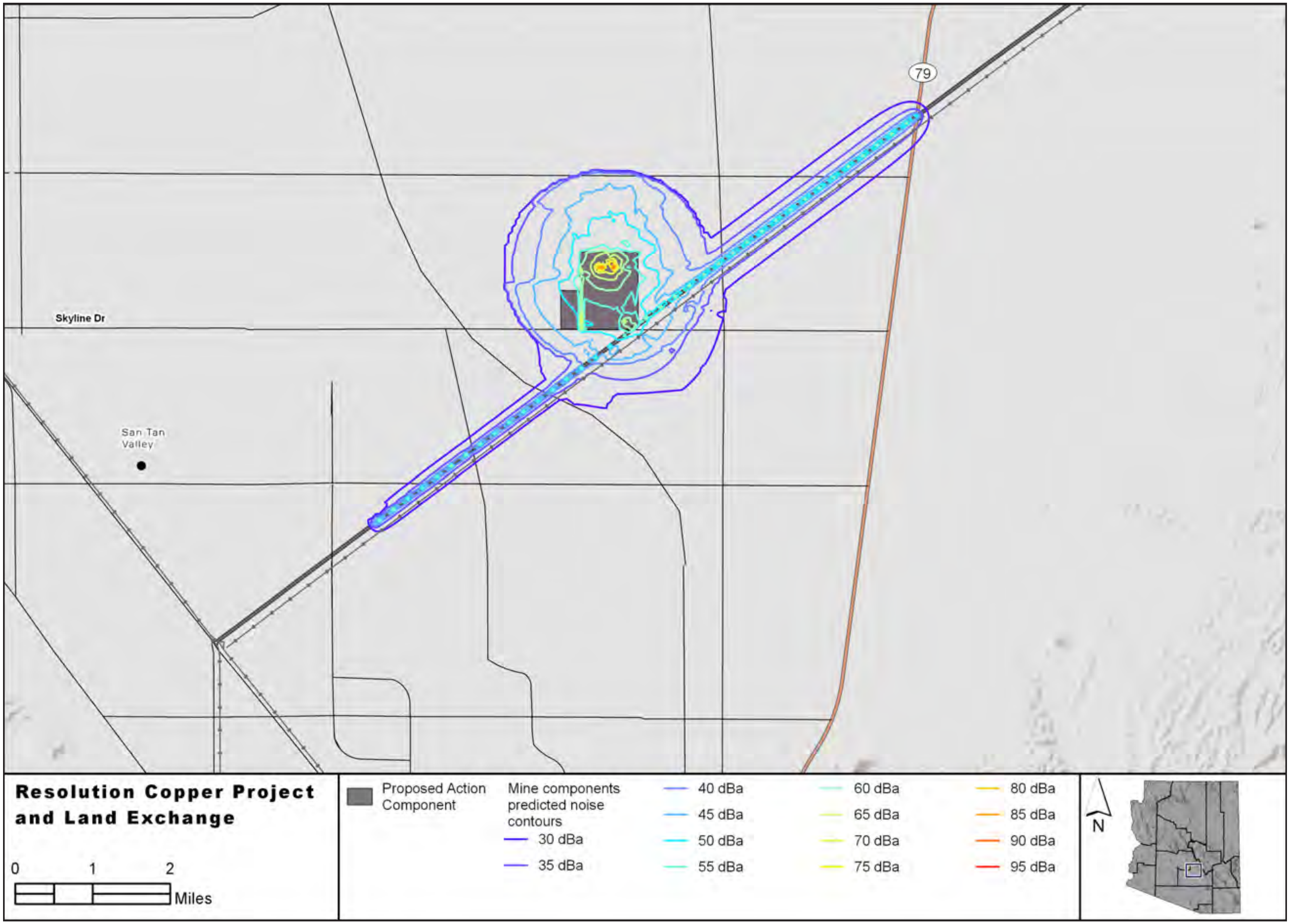


Figure 3.4.4-3. Predicted noise contours associated with Alternatives 2 and 3 (2 of 2)

Table 3.4.4-7. Predicted noise impacts during operations, Alternative 4, Leq(h) metric

Project Site	Sensitive Receptors	Future Levels, dBA						
		Project Predicted Levels	Project plus Background Levels			Increase Over Background Levels		
			Min	Avg	Max	Min	Avg	Max
West Plant Site	***Noise Measurement Location****	***47***	***47***	***49***	***50***	***3***	***5***	***14***
	Residences in Superior	47	47	49	50	3	5	14
	Residences U.S. 60 and Main Street[†]	53	53	55	**57**	3	4	15
East Plant Site	***Noise Measurement Location****	***61***	***61***	***61***	***61***	***11***	***12***	***16***
	Oak Flat Campground	43	43	49	51	1	1	12
	Apache Leap SMA	46	46	50	51	1	2	15
Filter Plant and Loadout Facility/ MARRCO corridor	***Noise Measurement Location****	***20***	***28***	***42***	***45***	***<1***	***<1***	***1***
	Westernstar Road	<10	27	42	45	<1	<1	<1
	Lind Road	32	33	43	45	<1	<1	6
	Felix Road	26	30	42	45	<1	<1	3
	Attaway Road	21	28	42	45	<1	<1	1
Silver King tailings storage facility	***Noise Measurement Location****	***52***	***52***	***52***	***52***	***11***	***14***	***25***
	Arizona Trail (northwest of Superior)	43	43	44	45	4	6	**16**

Notes: Shaded cells indicate an exceedance at a sensitive receptor of selected threshold of 55 dBA for project plus background levels, and 15 dBA for increase over background levels.
Min = Minimum, Avg = Average, Max = Maximum
* Prediction location is not a sensitive receptor and is included for comparison with the existing measured noise levels (see table 3.4.3-1).
† Lower and upper levels are based on the expected sound levels due to the vicinity of the highway (see table 3.4.3-1).

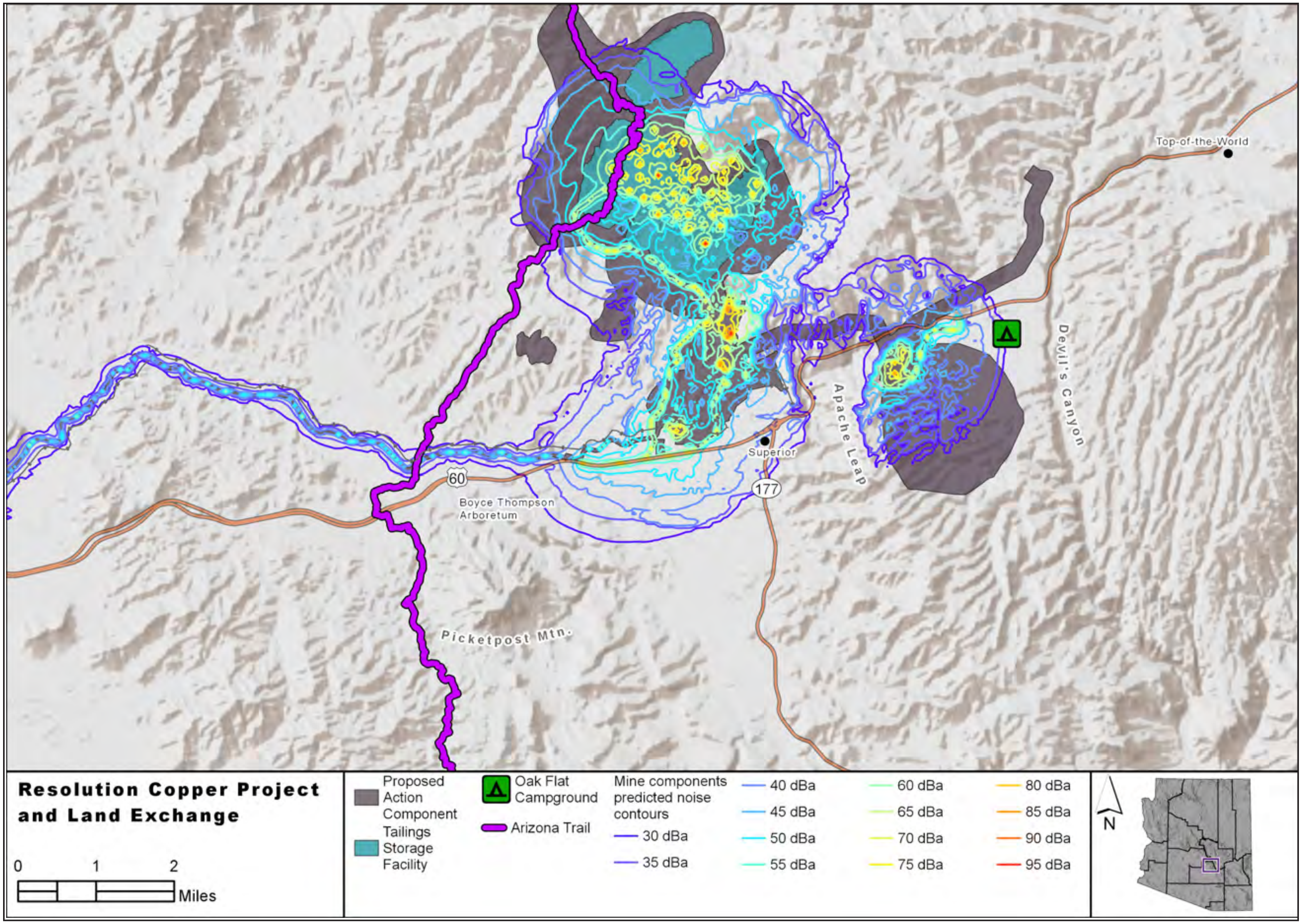


Figure 3.4.4-4. Predicted noise contours associated with operations, Alternative 4

3.4.4.5 Alternative 5 – Peg Leg

Alternative 5 would have identical impacts on Alternatives 2 and 3 for: construction blasting noise, construction blasting vibration, construction non-blasting noise, and operations non-blasting vibration. Only operational noise impacts would differ and are described here.

Similar to Alternatives 2 and 3, table 3.4.4-9 shows that noise impacts in Leq(h) metric are not expected to occur based on the predicted minimum and average noise level (whether looking at overall combined noise levels [project noise plus background noise], or the incremental noise increase over background levels). If the maximum of each range is used, incremental increases are at or above the selected threshold of 15 dBA at the following receptors:

- Residential receptors near U.S. 60 and Main Street.
- Recreational users within Apache Leap SMA.

The maximum condition assumes all equipment operating simultaneously during the quietest period; this would be an infrequent and unlikely occurrence.

Residential receptors near U.S. 60 and Main Street would also experience future levels above 55 dBA, but below 66 dBA, based on maximum values. Table 3.4.4-10 shows that predicted future noise levels in Ldn metric would comply with all the selected thresholds. Figure 3.4.4-5 shows the predicted noise contours for Alternative 5.

3.4.4.6 Alternative 6 – Skunk Camp

Alternative 6 would have identical impacts on Alternatives 2 and 3 for construction blasting noise, construction blasting vibration, construction non-blasting noise, and operations non-blasting vibration. Only operational noise impacts would differ and are described here.

Table 3.4.4-11 shows that noise impacts in Leq(h) metric are not expected to occur based on the predicted minimum and average noise level, except along Dripping Springs Road. There, the expected sound levels exceed the Leq(h) selected threshold of 55 dBA but are below the selected threshold of 66 dBA. If the maximum of each range is used, incremental increases are at or above the selected threshold of 15 dBA at the following receptors:

- Residential receptors near U.S. 60 and Main Street.
- Recreational users within Apache Leap SMA.
- Residential/recreational users along Dripping Springs Road.

The maximum condition assumes all equipment operating simultaneously during the quietest period; this would be an infrequent and unlikely occurrence.

Residential receptors near U.S. 60 and Main Street would also experience future levels above 55 dBA, but below 66 dBA, based on maximum values. For the Ldn metric, noise levels along Dripping Springs Road are also above the selected threshold of 65 dBA, as shown in table 3.4.4-12. Figure 3.4.4-6 shows the predicted noise contours for Alternative 6.

3.4.4.7 Cumulative Effects

The Tonto National Forest has identified the following list of reasonably foreseeable future actions as likely to occur in conjunction with development of the Resolution Copper Mine. The projects described here are expected, or have potential, to contribute to incremental changes in the existing noise and vibration conditions near the Resolution Copper Mine. As noted in section 3.1, past and present actions are assessed as part of the affected environment; this section analyzes the effects of any RFFAs, to be considered cumulatively along with the affected environment and Resolution Copper Project effects.

- *Pinto Valley Mine Expansion.* The Pinto Valley Mine is an existing open-pit copper and molybdenum mine located approximately 8 miles west of Miami, Arizona, in Gila County. Pinto Valley Mining Corporation is proposing to expand mining

Table 3.4.4-8. Predicted noise impacts during operations, Alternative 4, Ldn metric

		Future Levels, dBA						
		Project Predicted Levels	Project plus Background Levels			Increase Over Background Levels		
Project Site	**Sensitive Receptors**		**Min**	**Avg**	**Max**	**Min**	**Avg**	**Max**
West Plant Site	Noise Measurement Location*	***54***	***54***	***56***	***57***	***4***	***5***	***11***
	Residences in Superior	54	54	56	57	4	5	11
	Residences U.S. 60 and Main Street†	59	59	60	60	6	7	11
East Plant Site	Noise Measurement Location*	***67***	***67***	***67***	***67***	***13***	***16***	***26***
	Oak Flat Campground	50	51	54	55	1	2	10
	Apache Leap SMA	52	55	56	56	2	2	4
Filter plant and loadout facility/ MARRCO corridor	Noise Measurement Location*	***18***	***38***	***46***	***48***	***<1***	***<1***	***<1***
	Westernstar Road	<10	38	46	48	<1	<1	<1
	Lind Road	30	39	46	48	<1	<1	1
	Felix Road	24	38	46	48	<1	<1	<1
	Attaway Road	19	38	46	48	<1	<1	<1
Silver King tailings storage facility	Noise Measurement Location*	***57***	***57***	***57***	***57***	***11***	***14***	***22***
	Arizona Trail (northwest of Superior)	49	49	50	51	5	6	14

Notes: Shaded cells indicate an exceedance at a sensitive receptor of selected threshold of 65 dBA for project plus background levels, and 15 dBA for increase over background levels.
Min = Minimum, Avg = Average, Max = Maximum
* Prediction location is not a sensitive receptor and is included for comparison with the existing measured noise levels (see table 3.4.3-1).
† Lower and upper levels are based on the expected sound levels due to the vicinity of the highway (see table 3.4.3-1).

Table 3.4.4-9. Predicted noise impacts during operations, Alternative 5, Leq(h) metric

Project Site	Sensitive Receptors	Future Levels, dBA						
		Project Predicted Levels	Project plus Background Levels			Increase Over Background Levels		
			Min	Avg	Max	Min	Avg	Max
West Plant Site	***Noise Measurement Location****	***47***	***47***	***49***	***50***	***3***	***5***	***14***
	Residences in Superior	47	47	49	50	3	5	14
	Residences U.S. 60 and Main Street†	53	53	55	**57**	3	4	15
East Plant Site	***Noise Measurement Location****	***61***	***61***	***61***	***61***	***11***	***12***	***16***
	Oak Flat Campground‡	43	43	49	51	1	1	12
	Apache Leap SMA‡	46	46	50	51	1	2	15
Filter plant and loadout facility/ MARRCO corridor	***Noise Measurement Location****	***47***	***47***	***48***	***49***	***4***	***6***	***20***
	Westernstar Road	<10	27	42	45	<1	<1	<1
	Lind Road	32	33	43	45	<1	<1	6
	Felix Road	26	30	42	45	<1	<1	3
	Attaway Road	13	27	42	45	<1	<1	<1
Peg Leg tailings storage facility	***Noise Measurement Location****	***56***	***56***	***57***	***57***	***6***	***9***	***30***
	Arizona Trail (near Zellweger Wash)	34	35	48	51	<1	<1	9

Notes: Shaded cells indicate an exceedance at a sensitive receptor of selected threshold of 55 dBA for project plus background levels, and 15 dBA for increase over background levels.
Min = Minimum, Avg = Average, Max = Maximum
* Prediction location is not a sensitive receptor and is included for comparison with the existing measured noise levels (see table 3.4.3-1).
† Lower and upper levels are based on the expected sound levels due to the vicinity of the highway (see table 3.4.3-1).
‡ The expected lower level was applied to be conservative (see table 3.4.3-1).

Table 3.4.4-10. Predicted noise impacts during operations, Alternative 5, Ldn metric

Project Site	Sensitive Receptors	Project Predicted Levels	Future Levels, dBA: Project plus Background Levels Min	Avg	Max	Increase Over Background Levels Min	Avg	Max
West Plant Site	***Noise Measurement Location****	***54***	***54***	***56***	***57***	***4***	***5***	***11***
	Residences in Superior	54	54	56	57	4	5	11
	Residences U.S. 60 and Main Street†	59	59	60	60	6	7	11
East Plant Site	***Noise Measurement Location****	***67***	***67***	***67***	***67***	***13***	***16***	***26***
	Oak Flat Campground‡	50	51	54	55	1	2	10
	Apache Leap SMA‡	52	55	56	56	2	2	4
Filter plant and loadout facility/ MARRCO corridor	***Noise Measurement Location****	***53***	***53***	***54***	***54***	***6***	***8***	***15***
	Westernstar Road	<10	38	46	48	<1	<1	<1
	Lind Road	30	39	46	48	<1	<1	1
	Felix Road	24	38	46	48	<1	<1	<1
	Attaway Road	11	38	46	48	<1	<1	<1
Peg Leg tailings storage facility	***Noise Measurement Location****	***62***	***62***	***62***	***62***	***10***	***13***	***28***
	Arizona Trail (near Zellweger Wash)	40	41	50	52	<1	1	7

Notes: Shaded cells indicate an exceedance at a sensitive receptor of selected threshold of 65 dBA for project plus background levels, and 15 dBA for increase over background levels.
Min = Minimum, Avg = Average, Max = Maximum
* Prediction location is not a sensitive receptor and is included for comparison with the existing measured noise levels (see table 3.4.3-1).
† Lower and upper levels are based on the expected sound levels due to the vicinity of the highway (see table 3.4.3-1).
‡ The expected lower level was applied to be conservative (see table 3.4.3-1).

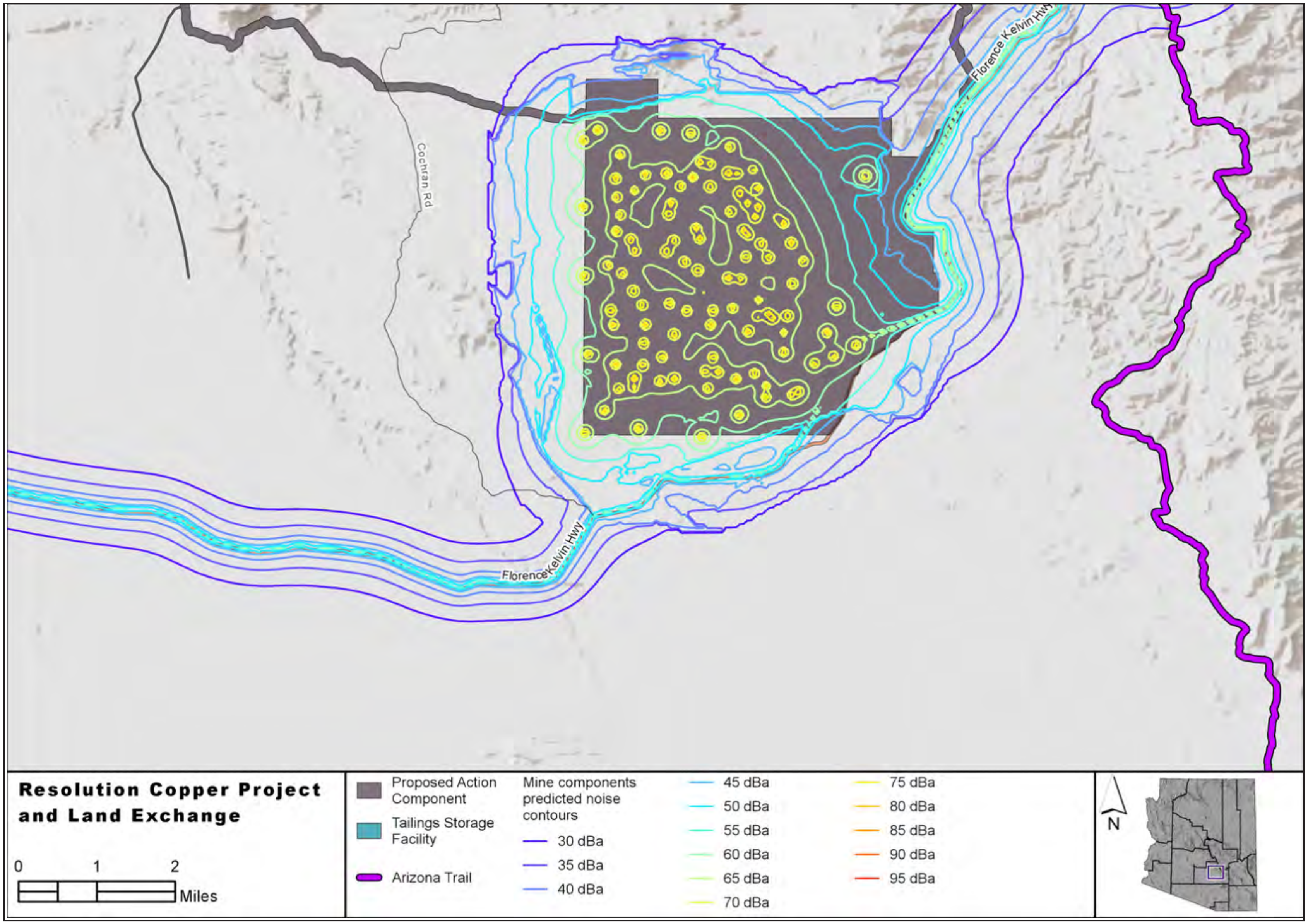


Figure 3.4.4-5. Predicted noise contours associated with operations, Alternative 5

Table 3.4.4-11. Predicted noise impacts during operations, Alternative 6, Leq(h) metric

Project Site	Sensitive Receptors	Future Levels, dBA						
		Project Predicted Levels	Project plus Background Levels			Increase Over Background Levels		
			Min	Avg	Max	Min	Avg	Max
West Plant Site	***Noise Measurement Location****	***47***	***47***	***49***	***50***	***3***	***5***	***14***
	Residences in Superior	47	47	49	50	3	5	14
	Residences U.S. 60 and Main Street†	53	53	55	**57**	3	4	15
East Plant Site	***Noise Measurement Location****	***61***	***61***	***61***	***61***	***11***	***12***	***16***
	Oak Flat Campground‡	43	43	49	51	1	1	12
	Apache Leap SMA‡	46	46	50	51	1	2	15
Filter Plant and Loadout Facility/ MARRCO corridor	***Noise Measurement Location****	***47***	***47***	***48***	***49***	***4***	***6***	***20***
	Westernstar Road	<10	27	42	45	<1	<1	<1
	Lind Road	32	33	43	45	<1	<1	6
	Felix Road	26	30	42	45	<1	<1	3
	Attaway Road	13	27	42	45	<1	<1	<1
Skunk Camp tailings storage facility	Arizona Trail (near Kelvin)§	<10	26	48	51	<1	<1	<1
	Dripping Springs Road	60	**60**	**60**	**60**	10	12	**34**

Notes: Shaded cells indicate an exceedance at a sensitive receptor of selected threshold of 55 dBA for project plus background levels, and 15 dBA for increase over background levels.
Min = Minimum, Avg = Average, Max = Maximum
* Prediction location is not a sensitive receptor and is included for comparison with the existing measured noise levels (see table 3.4.3-1).
† Lower and upper levels are based on the expected sound levels due to the vicinity of the highway (see table 3.4.3-1).
‡ The expected lower level was applied to be conservative (see table 3.4.3-1).
§ The lower and upper levels are based on the Peg Leg noise measurement location (see table 3.4.3-1).

Table 3.4.4-12. Predicted noise impacts during operations, Alternative 6, Ldn metric

Project Site	Sensitive Receptors	Future Levels, dBA						
		Project Predicted Levels	Project plus Background Levels			Increase Over Background Levels		
			Min	Avg	Max	Min	Avg	Max
West Plant Site	***Noise Measurement Location****	***54***	***54***	***56***	***57***	***4***	***5***	***11***
	Residences in Superior	54	54	56	57	4	5	11
	Residences U.S. 60 and Main Street†	59	59	60	60	6	7	11
East Plant Site	***Noise Measurement Location****	***67***	***67***	***67***	***67***	***13***	***16***	***26***
	Oak Flat Campground‡	50	51	54	55	1	2	10
	Apache Leap SMA‡	52	55	56	56	2	2	4
Filter Plant and Loadout Facility/ MARRCO corridor	***Noise Measurement Location****	***53***	***53***	***54***	***54***	***6***	***8***	***15***
	Westernstar Road	<10	38	46	48	<1	<1	<1
	Lind Road	30	39	46	48	<1	<1	1
	Felix Road	24	38	46	48	<1	<1	<1
	Attaway Road	11	38	46	48	<1	<1	<1
Skunk Camp tailings storage facility	Arizona Trail (near Kelvin)§	<10	34	49	52	<1	<1	<1
	Dripping Springs Road	67	**67**	**67**	**67**	**15**	**18**	**33**

Notes: Shaded cells indicate an exceedance at a sensitive receptor of selected threshold of 65 dBA for project plus background levels, and 15 dBA for increase over background levels.

Min = Minimum, Avg = Average, Max = Maximum

* Prediction location is not a sensitive receptor and is included for comparison with the existing measured noise levels (see table 3.4.3-1).

† Lower and upper levels are based on the expected sound levels due to the vicinity of the highway (see table 3.4.3-1).

‡ The expected lower level was applied to be conservative (see table 3.4.3-1).

§ The lower and upper levels are based on the Peg Leg noise measurement location (see table 3.4.3-1).

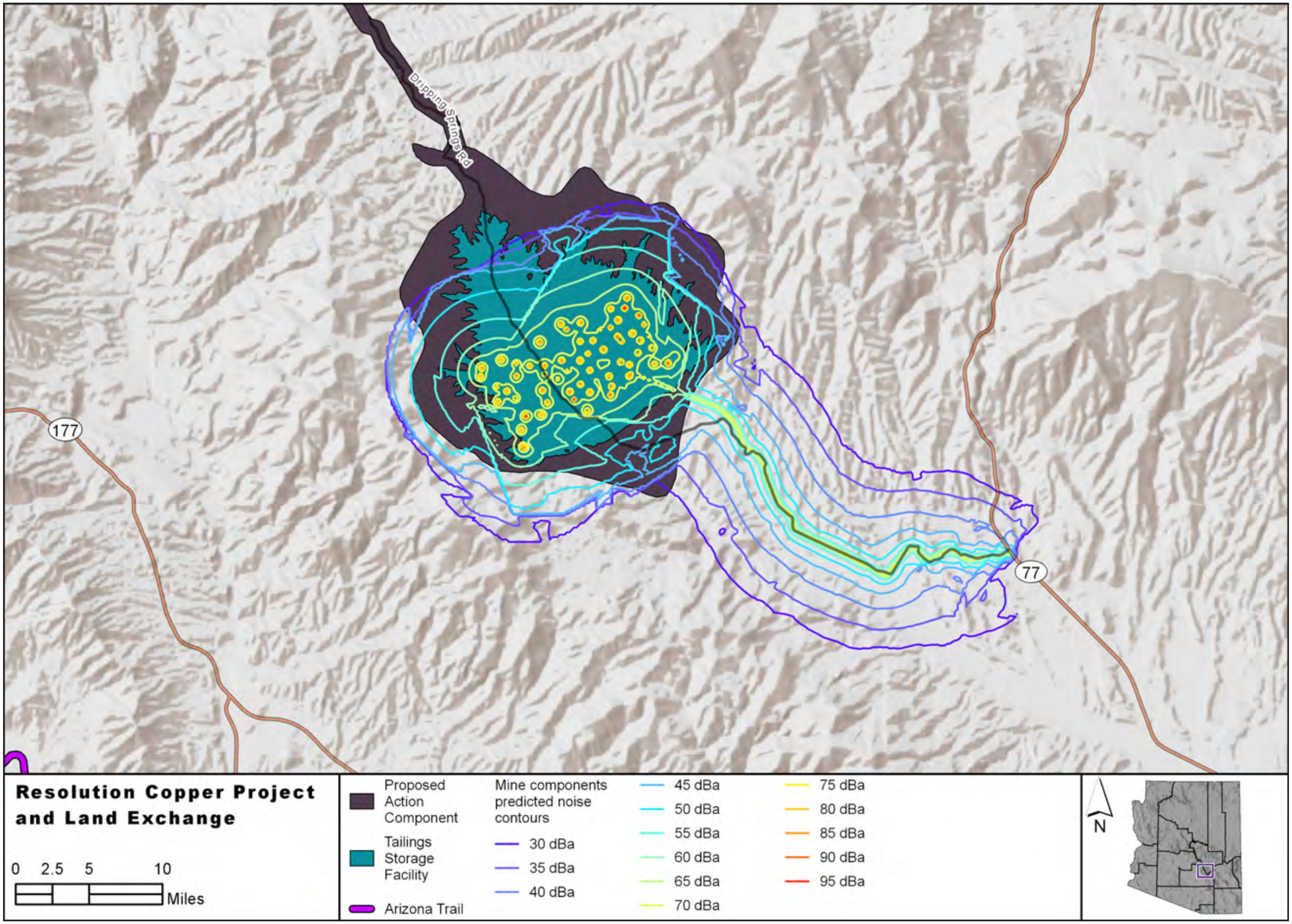


Figure 3.4.4-6. Predicted noise contours associated with operations, Alternative 6

activities onto the Tonto National Forest and extend the life of the mine to 2039. EIS impact analysis is pending; however, continued mine operations associated with the expansion over the next 20 years would contribute to equivalent or possibly increased noise and vibration levels perceptible to nearby residences and/or recreational users of adjacent lands. Because the effects of noise and vibration at the mine property would be relatively limited geographically and quickly attenuate with distance, analysis of those effects as a cumulative effect is not considered necessary. However, noise and vibrations from increased haul truck traffic could contribute to cumulative effects for residences and along major roadways.

- *Silver Bar Mining Regional Landfill and Cottonwood Canyon Road*. AK Mineral Mountain, LLC, NL Mineral Mountain, LLC, POG Mineral Mountain, LLC, SMT Mineral Mountain, LLC, and Welch Mineral Mountain, LLC are proposing to build a municipal solid waste landfill on private property surrounded by BLM land (Middle Gila Canyons area). Site access would require crossing BLM land. The owners/developers and Pinal County have applied for a BLM right-of-way grant and Temporary Use Permit for two temporary construction sites to obtain legal access to the private property and authorization of the needed roadway improvements. The proposed action includes improving a portion of the existing Cottonwood Canyon Road and a portion of the existing Sandman Road in order to accommodate two-way heavy truck traffic to and from the proposed landfill. Traffic generated by the planned landfill would significantly increase the overall annual daily traffic on Cottonwood Canyon Road. Average annual daily traffic would increase by approximately 367 percent (303 percent during winter months and 549 percent in summer). Traffic generated by the landfill would primarily consist of tractor/trailer vehicles with a gross weight of over 80,000 pounds. Mineral Mountain Road and Price Road are likely to be impacted by displaced traffic due to temporary closures and disruption of access on Cottonwood Canyon Road. Noise impacts would be expected to increase notably on local roads due to increased traffic, with minor impacts from vibration.
- *Ray Land Exchange and Proposed Plan Amendment*. ASARCO is also seeking to complete a land exchange with the BLM by which the mining company would gain title to approximately 10,976 acres of public lands and federally owned mineral estate located near ASARCO's Ray Mine in exchange for transferring to the BLM approximately 7,304 acres of private lands, primarily in northwestern Arizona. It is known that at some point ASARCO wishes to develop a copper mining operation in the "Copper Butte" area west of the Ray Mine. Under the proposed action, noise and vibration impacts on the selected lands would be expected to increase with the development of new mining activity. No specific noise or vibration impacts are anticipated in association with the offered lands, as they would have come under the administration of the BLM, and thus be subject to respective resource management plan strategies.
- *ADOT Vegetation Treatment*. ADOT plans to conduct annual treatments using EPA-approved herbicides to contain, control, or eradicate noxious, invasive, and native plant species that pose safety hazards or threaten native plant communities on road easements and NFS lands up to 200 feet beyond road easement on the Tonto National Forest. It can be reasonably assumed that ADOT would continue to conduct vegetation treatments along U.S. 60 on the Tonto National Forest during the expected life of the Resolution Copper Mine (50–55 years) for safety reasons. The vegetation treatment may result in short-term noise impacts along roadways but generally would be minimal and not cumulative with Resolution Copper Project impacts.

Other unplanned large-scale mine developments in the area are likely to occur during the foreseeable life of the Resolution Copper Mine (50–55 years). Large-scale mining would affect the ambient noise and vibration conditions perceived by sensitive receptors during both the short-term exploration phases and the longer term operational phases. The Tonto Nation Forest's Travel Management Plan would alter localized traffic

noise slightly, as the plan would include rerouting various NFS roads, which could contribute to cumulative noise impacts. Additionally, construction of other planned and unplanned projects such as pipelines and/or transmission lines could also contribute to noise and vibration, but impacts would be short term and occur only during construction or maintenance.

3.4.4.8 Mitigation Effectiveness

The Forest Service is in the process of developing a robust mitigation plan to avoid, minimize, rectify, reduce, or compensate for resource impacts that have been identified during the process of preparing this EIS. Appendix J contains descriptions of mitigation concepts being considered and known to be effective, as of publication of the DEIS. Appendix J also contains descriptions of monitoring that would be needed to identify potential impacts and mitigation effectiveness. As noted in chapter 2 (section 2.3), the full suite of mitigation would be contained in the FEIS, required by the ROD, and ultimately included in the final GPO approved by the Forest Service. Public comment on the EIS, and in particular appendix J, will inform the final suite of mitigations.

This section contains an assessment of the effectiveness of design features from the GPO and mitigation and monitoring measures found in appendix J that are applicable to noise and vibration.

Mitigation Measures Applicable to Noise and Vibration

Alternate road access to Skunk Camp tailings storage facility (RC-218): Resolution Copper proposes to construct an alternate access route to the Skunk Camp tailings storage facility to reduce noise at residences along Dripping Springs Road. This action seeks to mitigate impacts related to noise, dust, and traffic and is relevant only to Alternative 6. If implemented, the measure would be required by the Forest Service in the final ROD and final mining plan of operations. Several possible routes are considered. A southern route would bypass residences along Dripping Springs Road. This could be used for the life of operations but may be most beneficial during the initial construction period of the embankment. A northern route would provide access from SR 77 to the northern portion of the tailings storage facility area and completely bypass Dripping Springs Road.

Mitigation Effectiveness and Impacts

Of all expected operational noise impacts, the most substantial impact identified in the analysis was on residences or recreational users along Dripping Springs Road; these impacts would be caused by mine traffic. Rerouting of traffic off this road would be effective at eliminating this noise impact. The construction of the southern alternate access route would potentially require 364 acres of additional ground disturbance based on 1,000 feet of right-of-way for construction and would be 3.1 miles long. The construction of the northern alternate access route would potentially require 1,391 acres of additional ground disturbance based on 1,000 feet of right-of-way for construction and would be 11.9 miles long.

Unavoidable Adverse Impacts

No impacts above selected thresholds were identified from construction blasting noise and vibration (provided explosive loading is appropriately limited), from construction non-blasting noise (beyond 1,000 feet from active equipment), or from operational vibrations (beyond 50 feet from active equipment).

For operational noise, with the exception of Dripping Springs Road, the only impacts identified above selected thresholds were associated with the maximum range of impacts, which is an infrequent and unlikely scenario that suggests that all equipment is running simultaneously and during the quietest period (i.e., lowest background levels observed). Under most conditions, the analysis indicates that no impacts would be expected from project noise.

Application of the mitigation of rerouting traffic from Dripping Springs Road would eliminate those operational noise impacts as well.

After mitigation, no unavoidable adverse impacts are anticipated from noise or vibration.

3.4.4.9 Other Required Disclosures

Short-Term Uses and Long-Term Productivity

Noise and vibration levels did not rise beyond threshold of concern under most conditions, but the noise and vibration associated with the surrounding environment from mining and associated activities would be short term (during the estimated 51- to 56-year life of the mine, including construction, operations, and reclamation) and are expected to end with mine reclamation.

Irreversible and Irretrievable Commitment of Resources

Irretrievable commitment of resources would consist of mine-related noise during the construction, mining, closure, and reclamation phases of the mine. Because the mine-related noise would cease after closure of the mine, noise impacts would not be considered an irreversible commitment of resources.

Overview

Transportation of personnel, equipment, supplies, and materials related to development, operation, and closure/reclamation of the proposed Resolution Copper Mine would, under any alternative, substantially increase traffic in the greater Superior area. The anticipated increase in mine-related traffic on local roads and highways is likely to alter local and regional traffic patterns, levels of service, future transportation-related projects, and may adversely affect users of NFS roads through road closures and other changes to the existing system. Higher traffic volumes may also noticeably contribute to accelerated deterioration of local roadways, requiring higher levels of taxpayer-funded maintenance and more frequent repair of local roads and highways.

3.5 Transportation and Access

3.5.1 Introduction

The analysis presented in this section of the EIS examines the most likely effects on regional and local road transportation systems under each of the alternatives. This section summarizes the roads and intersections in the area, along with their background traffic levels and level of service, and assesses the impacts from mine traffic to traffic volume, level of service, and changes in transportation routes and public access.

Some aspects of the analysis are briefly summarized in this section. Additional details not included are in the project record (Newell 2018h).

3.5.2 Analysis Methodology, Assumptions, and Uncertain and Unknown Information

3.5.2.1 Analysis Area

The transportation and access analysis area for the proposed mine facilities and alternatives includes the roads adjacent to the proposed mine, roads that would provide regional access to the proposed mine and its facilities, roads within or cut off by the perimeter fence that would be inaccessible to the public from mine activities, the proposed primary access roads and utility maintenance roads, as well as numerous less-frequently used and/or recreational routes that may potentially be affected by a general increase in area traffic. This 82,188-acre analysis area is depicted in figure 3.5.2-1. The analysis area for transportation and access issues includes within its boundaries approximately 141 miles of State highways, 418 miles of Pinal County–owned and local roads, and 533 miles of NFS roads.

Temporary haul and mine operations roads within the mine perimeter fence would not be part of the NFS transportation system. However, in order to capture all potential disturbance, we include any impacts that would result from the creation, use, and disposal of temporary or long-term mine haul and service roads in the total site disturbance acreage calculations in this section.

Figure 3.5.2-1 also depicts several key intersections that are used in the transportation analysis. The intersections where there would be increased traffic because of the mine are the critical locations that most affect the level of service (LOS), which is a qualitative measure of how road capacity is perceived by drivers. Traffic impact modeling focuses on these key intersections.

To support this modeling, existing peak-hour turning movement counts were collected at 16 intersections within the analysis area. Twenty-four-hour bidirectional traffic volume, speed, and classification counts were collected along 16 roadway segments within the analysis area. At ADOT's direction, Resolution Copper collected data during both the summer and winter seasons to provide a conservative estimate of average daily traffic and peak-hour turning movements.

Because we use projections of future growth in non-mine traffic, for traffic impacts we have to assume a specific year at which construction and operations would begin. Traffic projections assume a peak construction year of 2022, with operations beginning in 2027. To minimize the possibility

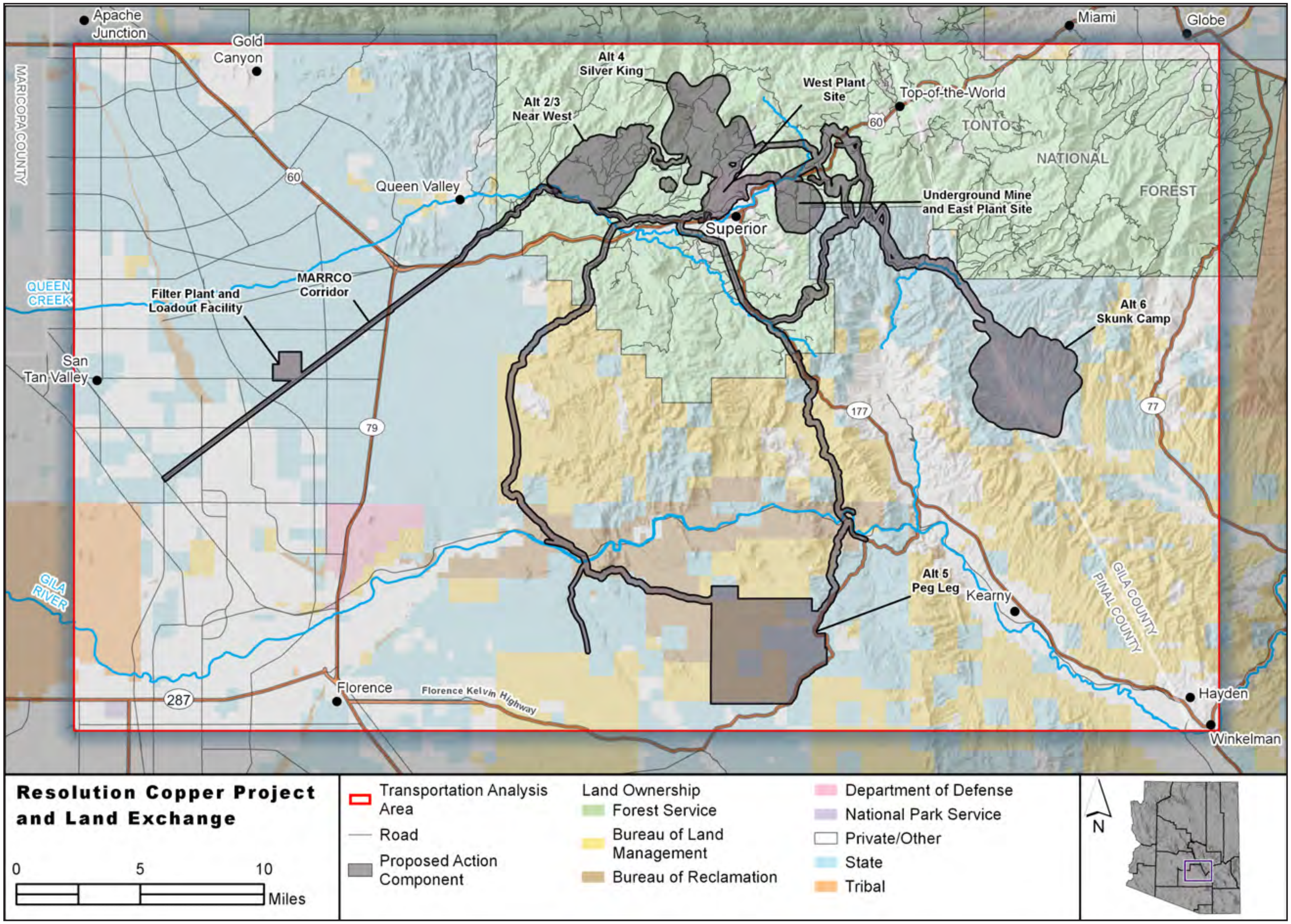


Figure 3.5.2-1. Transportation and access analysis area

of underrepresenting potential traffic and to ensure a conservative analysis of potential traffic impacts, we assumed that the highest number of applicable types of mine-related traffic would use the analyzed transportation network during the peak construction year. To this end, the analysis assumes that the peak construction year (2022) would include concurrent construction of the East Plant Site, the West Plant Site, the tailings storage facility, the filter plant, and the loadout facility. Traffic generated at the peak construction year represents the greatest increase in traffic over background conditions.

We assume regular operations would begin in 2027. Regular operations consist of a combination of employee trips and material supply deliveries for the East Plant Site, the West Plant Site, the tailings storage facility, the filter plant, and the loadout facility. The traffic employee and supply trips generate during normal operations is significantly less than during the peak year of construction.

We estimated the distribution for the project-generated trips based on the relative accessibility of cities and towns near the site. Based on an assumed location of material suppliers and the availability of employee housing, we expect that the trips generated for both the construction and the normal operation of the facility share a similar distribution. Of the trips we expect to be generated, 68 percent would originate from the Phoenix/Mesa metropolitan area via U.S. 60. Another 17 percent would originate from the San Tan Valley/Florence area via SR 79. Based on the data, we believe the trips from these areas would have destinations to either the filter plant and loadout facility or to the mining facilities at the East Plant Site, the West Plant Site, and the tailings storage facility. Trips from the west represent 85 percent of the total trips generated. The remaining 15 percent of generated trips are expected from the east. Of these trips, we expect 10 percent to originate along U.S. 60 toward Globe, and 5 percent from SR 177 south of Superior.

Much of the analysis contained in this section can be found in the traffic impact analysis reports (Southwest Traffic Engineering LLC 2016, 2017, 2018). Many details of NFS roads can be found in the travel management plan prepared by the Tonto National Forest (U.S. Forest Service 2016e).

3.5.3 Affected Environment

3.5.3.1 Relevant Laws, Regulations, Policies, and Plans

Primary Guidance Relevant to the Transportation and Access Analysis
• “Roadway Design Guidelines,” ADOT, May 2012
• “Traffic Guidelines and Processes,” ADOT, June 2015
• “Low Volume Roads Engineering Best Management Practices Field Guide,” Gordon Keller, PE, and James Sherar, PE, July 2003
• Forest Service Handbook 7709.56 (Road Preconstruction), July 2011
• Forest Service Handbook 7709.59 (Road System Operations), February 2009
• Forest Service Manual 7710 (Transportation Planning Handbook), May 1991
• “Guidelines for Geometric Design of Very Low-Volume Local Roads,” American Association of State Highway and Transportation Officials, 2001

Forest Service Guidance

FSH 7709.59, "Road System Operations and Maintenance" (U.S. Forest Service 2009), provides guidance for planning, traffic management, investment sharing (cost share), highway safety, traffic studies, road maintenance, and other NFS road operations and maintenance activities. Such road system operations and maintenance are part of the process of managing NFS roads and road uses to best meet land and resource management objectives.

Before any roads are added to or removed from the NFS road system, they must undergo travel analysis, as described in Forest Service Manual (FSM) 7703.26 (U.S. Forest Service 2010a), "Adding Roads to the Forest Transportation System." Travel analysis considers the values affected by roads, including access to and use of, protection of, and administration of NFS lands; public health and safety; valid existing rights; and long-term road funding opportunities and obligations. Environmental analysis for roads includes effects on associated ecosystems; introduction of invasive species; effects on threatened and endangered species and areas with significant biodiversity, cultural resources, fish and wildlife habitat, water quality, and visual quality; effects on recreation opportunities; and effects on access to NFS lands. Travel analysis requirements are met for the NFS roads analyzed in this EIS. Roads on private land and roads under the jurisdiction of entities other than the Forest Service are not required to undergo travel analysis. Road width, surfacing, and grades for segments of the access roads that would be NFS roads must meet or exceed Forest Service standards or have appropriate professional engineering justification and Forest Service approval for deviations from Forest Service standards.

NFS lands within the analysis area are generally accessed by high-clearance vehicle roads, known as maintenance level 2 roads. Forest Service upkeep of maintenance level 2 roads typically occurs as needed, depending on funding, and usually in response to damage caused by use and/or erosion. Should the proponent desire or require maintenance to a higher standard to reliably and comfortably allow standard passenger car use, highway-legal truck use, or other specific vehicular use of an NFS road, the proponent must be authorized in writing to perform such maintenance or provide funding to the Forest Service sufficient to allow the Forest Service to perform or contract for the performance of the needed maintenance.

State and Other Guidance

ADOT has exclusive jurisdiction over State highways, State routes, and State-owned airports, as well as jurisdiction over all State-owned transportation systems or modes. ADOT has the responsibility to contribute the most desirable design parameters consistent with safety, service, environment, and cost effectiveness and to apply these parameters with sound engineering judgment on routes under State jurisdiction. The "Roadway Design Guidelines" (Arizona Department of Transportation 2014), with revisions and amendments, and the "Guidelines for Highways on Bureau of Land Management and U.S. Forest Service Lands" (Wheat Scharf Associates and ADOT/FHWA/BLM/USFS Steering Committee 2008) guide the roadway designer in exercising sound engineering judgment in applying design parameters. The 2014 guidelines are complementary to the American Association of State Highway and Transportation Officials' "A Policy on Geometric Design of Highways and Streets" (American Association of State Highway and Transportation Officials 2004) and the "Roadside Design Guide" (American Association of State Highway and Transportation Officials 2011) and are to be used in conjunction with these documents. The American Association of State Highway and Transportation Officials' policies reflect general nationwide practices and are not necessarily applicable to the conditions in Arizona. Where the design values provided in the ADOT manual differ from those presented in the American Association of State Highway and Transportation Officials' guidelines, the ADOT manual takes precedence. ADOT's "Guidelines for Highways on Bureau of Land Management and U.S. Forest Service Lands" (Wheat Scharf Associates and ADOT/FHWA/BLM/USFS Steering Committee 2008) are applicable only to ADOT roads on BLM and NFS lands.

Access and Authorizations

The Tonto National Forest and BLM manage Federal lands that are open to access by the public, subject to appropriate management restrictions. The Tonto National Forest currently manages in accordance with the Tonto National Forest Land and Resource Management Plan (1985b), which is in the process of revision. The BLM manages lands in the analysis area under either the "Phoenix Resource Management Plan/ Environmental Impact Statement, Record of Decision" (Bureau of Land Management 1989) or under the "Records of Decision, Final Safford District Resource Management Plan and Environmental Impact Statement" (Bureau of Land Management 1991, 1994b). Any roads, pipeline corridors, or power line corridors associated with the project placed on Federal lands must be approved by the appropriate agency, in conformance with management direction. Authorization could occur under several regulations, which will depend on the final decisions by the agency. Authorization of easements for the Tonto National Forest would occur either as part of approval of a mining plan of operations under mineral regulations (36 CFR 228 Subpart) or as a special use authorization under land use regulations (36 CFR 251). Similarly, BLM authorization of easements would occur either as part of approval of a mining plan of operations (43 CFR 3809) and/or as easements (43 CFR 2800).

Arizona State Trust lands are managed under the provisions of the Federal Enabling Act that provided for Arizona's statehood in 1912. Approximately 9.2 million acres throughout the state are currently held in trust. Although this is at ASLD's discretion, State Trust lands may be leased as a means of providing annual revenue for 14 officially recognized beneficiary agencies and entities (the largest recipient by far is Arizona K–12 education). Trust lands are less frequently for sale through a process of competitive bidding. For the purposes of this EIS, it is assumed that any State Trust lands underlying the two alternative tailings storage facility locations where State lands are present (Alternative 5 – Peg Leg or Alternative 6 – Skunk Camp) would be sold rather than leased, if that location were to be selected. That same assumption may be applied to the State Trust lands located within the predicted subsidence area at the East Plant Site.

3.5.3.2 Existing Conditions and Ongoing Trends

Highways and Roads Description

The following is a list of existing transportation systems within the analysis area. The systems described include State highways, county roads, and NFS roads. Figure 3.5.2-1 depicts the road facilities in relation to the analysis area.

STATE HIGHWAYS

- U.S. 60 is a four-lane divided highway that has an east-west alignment and a posted speed limit of either 45 miles per hour (mph), 50 mph, or 65 mph in the analysis area. The ADOT facility generally has no curb, gutter, or sidewalks provided in the area. U.S. 60 is considered a regional route linking Superior, Miami, and Globe to the Phoenix/Mesa metropolitan area. Between Silver King Mine Road (NFS Road 229) and SR 177, U.S. 60 includes a two-way left-turn lane.
- State Route 177 is an undivided two-lane roadway beginning at the intersection of U.S. 60/SR 177 and extending to the south toward the town of Kearny, Arizona. The roadway has no curb, gutter, or sidewalk facilities in the analysis area. The posted speed limit on SR 177 is 25 mph at the intersection of U.S. 60/ SR 177 and increases to 55 mph as the road leaves the town of Superior.
- State Route 79 has a north-south alignment and is a two-lane, undivided roadway with 10-foot paved shoulders. The posted speed limit on SR 79 is 65 mph. SR 79 provides a route from U.S. 60 south to Florence, Arizona. There are no curb, gutter, or sidewalk facilities along SR 79 within the project boundary. Approximately 2 miles south of U.S. 60, SR 79 crosses the existing MARRCO corridor.
- State Route 77 has a north-south alignment and a posted speed of 50 mph. The facility has one travel lane in each direction.

The roadway has no curb, gutter, or sidewalk facilities in the analysis area.

COUNTY ROADS AND LOCAL ROADS

- Main Street in Superior is an undivided two-lane local roadway with an east-west alignment. Curb, sidewalks, and bike lanes are present along the north and south sides of the roadway. West of Lonetree Road, Main Street is posted 35 mph. East of Lonetree Road, Main Street is posted 25 mph.
- Lonetree Road is a two-lane graded dirt road, providing access to various mining operations north of Main Street. There is no posted speed limit, curb, gutter, or sidewalks along Lonetree Road.
- Magma Avenue is a two-lane paved local roadway along a north-south alignment located in Superior. The roadway provides curb, gutter, sidewalks, and on-street parking along the eastern and western sides of the roadway. The posted speed limit on Magma Avenue is 25 mph.
- Skyline Drive is a two-lane roadway with no curb, gutter, or sidewalk facilities. The speed limit on Skyline Drive is 50 mph west of Quail Run Lane and 45 mph east of Quail Run Lane. There are existing overhead utility lines along the north side of the roadway. Low-density residential development is present on the north side of the roadway between Schnepf Road and Quail Run Lane and south of Skyline Drive east of Quale Run Lane. An RV park is on the south side of the roadway at Sierra Vista Drive. In general, the land surrounding Skyline Drive is largely undeveloped or used as farmland.
- Quail Run Lane is an undivided, two-lane roadway with a posted speed limit of 50 mph. The roadway has a north-south alignment, and does not provide curb, gutter, or sidewalk facilities.
- Sierra Vista Drive is an unpaved, two-lane dirt roadway with a posted speed limit of 25 mph. The roadway has a north-south alignment and no curb, gutter, or sidewalk facilities.
- Schnepf Road is an undivided two-lane roadway with a north-south alignment and a posted speed limit of 50 mph. There are dirt shoulders along both sides of the roadway and no sidewalk facilities.
- Combs Road has an east-west alignment and a posted speed limit of 50 mph. One travel lane is provided in each direction, with dirt shoulders along both sides of the roadway and no sidewalk facilities.
- Florence-Kelvin Highway has an east-west alignment and a posted speed of 50 mph. The roadway is both gravel surfaced and paved; it provides one travel lane in each direction. There are no curb, gutter, or sidewalk facilities along this route within the analysis area.
- Dripping Springs Road has an east-west alignment and no posted speed limit. The roadway is unpaved and provides one lane of travel in each direction. There are no curb, gutter, or sidewalk facilities.

NATIONAL FOREST SYSTEM ROADS

- Silver King Mine Road (also known as NFS Road 229) exists as a graded dirt roadway with a north-south alignment, providing access to State lands and various existing mining operations. There is no posted speed limit on Silver King Mine Road (NFS Road 229). Silver King Mine Road intersects U.S. 60 from the north. South of U.S. 60, the roadway is known as Apache Tear Road (NFS Road 989). Commonly used NFS roads in the project area are shown in figure 3.5.3-1.
- Apache Tear Road (NFS Road 989) is a graded dirt roadway that begins at a cattle guard adjacent to U.S. 60 and extends south, providing access to State lands, various mining

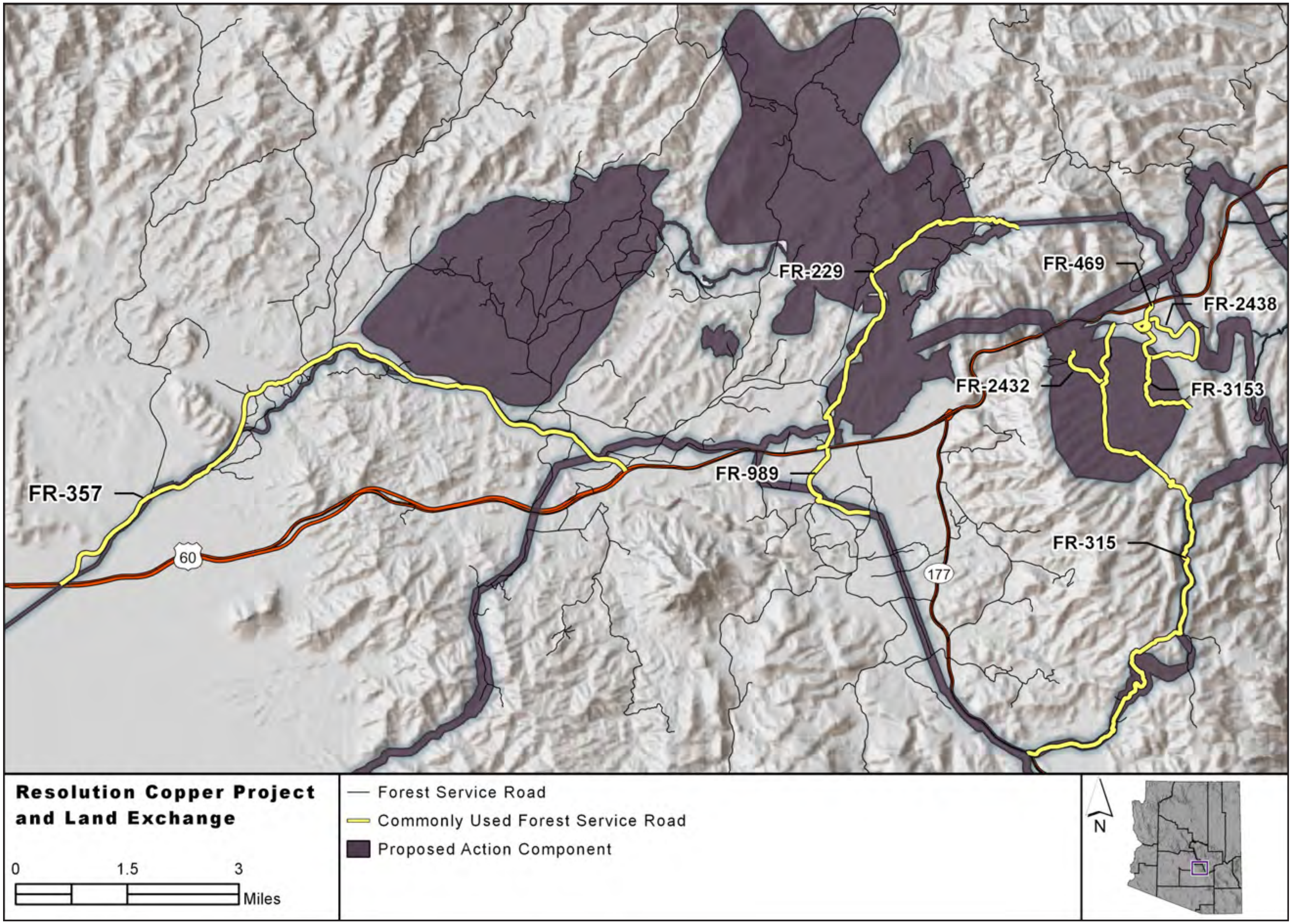


Figure 3.5.3-1. Commonly used NFS roads in the project area

operations, and the Town of Superior's water plant. Apache Tear Road (NFS Road 989) has a posted speed limit of 25 mph.

- Hewitt Station Road (NFS Road 357) is an unpaved, graded dirt road providing access to State lands as well as other recreational and off-road vehicle NFS roads north of U.S. 60. A dirt parking/ staging area for recreational users exists on the east side of Hewitt Station Road (NFS Road 357) immediately north of U.S. 60. Cattle guards are located across Hewitt Station Road (NFS Road 357) at the intersection with U.S. 60. There is no posted speed limit. There are currently access restrictions along this road where it crosses private property.
- Magma Mine Road (NFS Road 469) is a two-lane undivided paved roadway with no curb, gutter, or sidewalk facilities which provides access to mining operations south of U.S. 60. The Forest Service classifies Magma Mine Road (NFS Road 469) as a level 4 road. There is no posted speed limit. Beyond its intersection with East Oak Flats Road (NFS Road 2438), Magma Mine Road becomes NFS Road 315 with a level 2 road classification. This section of Magma Mine Road (NFS Road 315) is paved with a single lane. Magma Mine Road splits from NFS Road 315 approximately 5,800 feet from its intersection with East Oak Flats Road (NFS Road 2438), becoming a private road designated as NFS Road 2432.
- East Oak Flats Road (NFS Road 2438). Approximately 1,400 feet from U.S. 60, Magma Mine Road intersects with East Oak Flats Road (NFS Road 2438). East Oak Flats Road (NFS Road 2438) is an unpaved loop road classified as a level 2 road by the Forest Service. There is no posted speed limit.
- NFS Road 3153 intersects East Oak Flats Road (NFS Road 2438) and is an unpaved dead-end road classified as a level 2 road by the Forest Service. There is no posted speed limit. Current Forest Service documentation identifies this road as closed.

Background Traffic Volume Counts

Resolution Copper collected peak-hour turning movement counts in August 2015, to capture summer traffic patterns (Southwest Traffic Engineering LLC 2017, 2018). At ADOT's direction, counts were collected on a Friday between the hours of 7:00 a.m. and 10:00 p.m. Additional counts were collected in November 2016, during the same daily time frame to capture winter traffic patterns. Volume counts collected during the winter period were generally higher than the summer period. We analyzed the larger of the two count periods and adjusted for seasonal factors and background growth to provide for a conservative analysis; in other words, we analyzed more traffic rather than less traffic.

Resolution Copper completed turning movement counts at the following intersections, as shown in figure 3.5.3-2:

- Magma Mine Road (NFS Road 469)/U.S. 60
- SR 177/Eastbound U.S. 60 ramps
- SR 177/Westbound U.S. 60 on-ramp
- Ray Road/Heiner Street/Westbound U.S. 60 off-ramp
- Main Street/U.S. 60
- NFS Road 989/U.S. 60
- Silver King Mine Road (NFS Road 229)/U.S. 60
- Hewitt Station Road (NFS Road 357)/U.S. 60
- Main Street/Lonetree Road
- Main Street/Magma Avenue
- Skyline Drive/Quail Run Lane
- Skyline Drive/Sierra Vista Drive
- Skyline Drive/Schnepf Road
- Combs Road/Schnepf Road

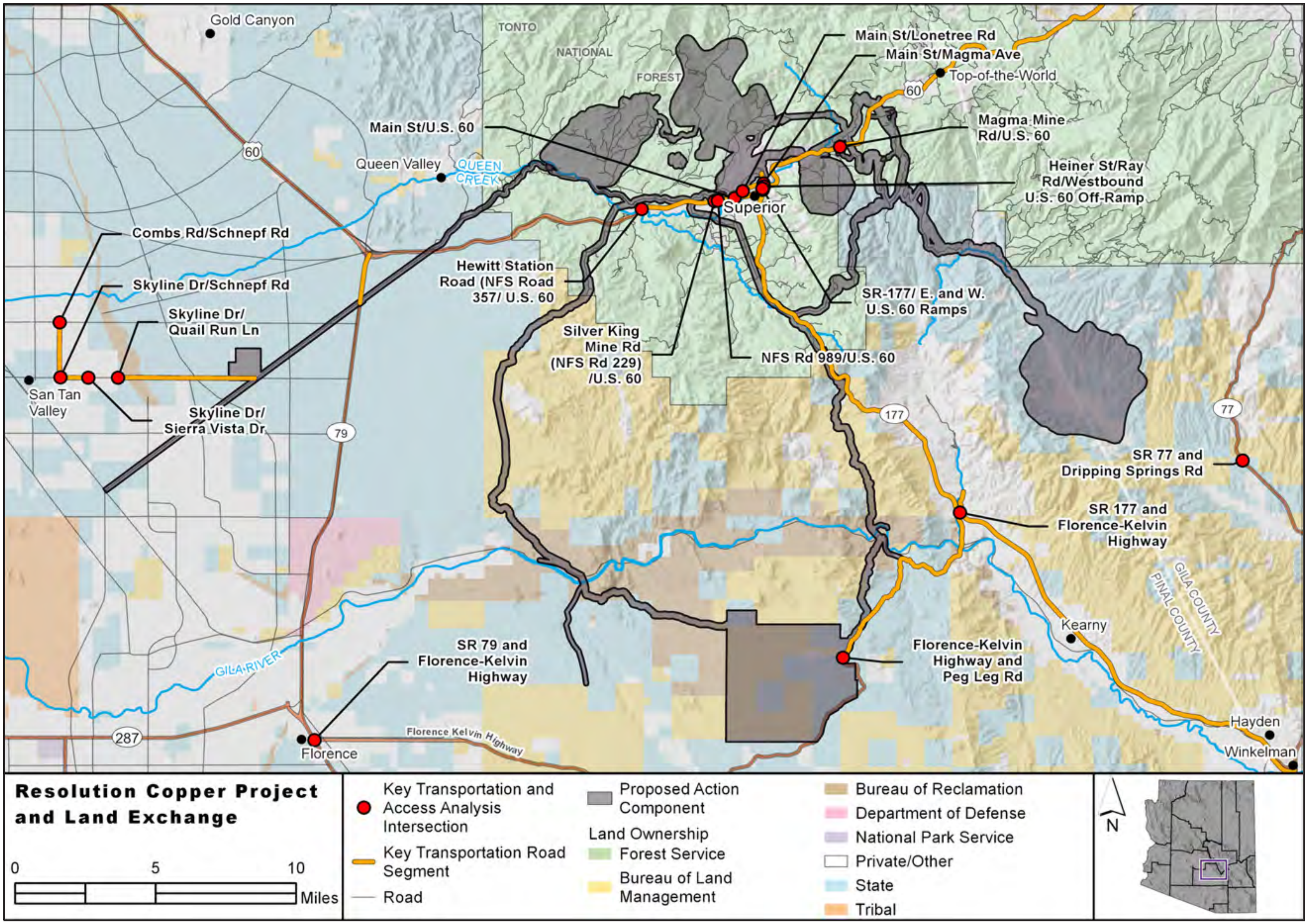


Figure 3.5.3-2. Key intersections and road segments analyzed through traffic counts

- Florence-Kelvin Highway/SR 79
- Florence-Kelvin Highway/SR 177
- Florence-Kelvin Highway/Peg Leg Road
- SR 77/Dripping Springs Road

In addition to intersection vehicle-turning movement counts, 24-hour bidirectional traffic volumes, vehicle speed, and vehicle classification counts were collected along roadway segments within or adjacent to the analysis area. These roadway segments are also depicted in figure 3.5.3-2:

- Magma Avenue, north of Copper Road
- Main Street, east of Pinal Avenue
- Main Street, west of Pinal Avenue
- U.S. 60, west of Silver King Mine Road (NFS Road 229)
- U.S. 60, between Silver King Mine Road (NFS Road 229) and Main Street
- U.S. 60, between Main Street and SR 177
- U.S. 60, west of Magma Mine Road (NFS Road 469)
- U.S. 60, east of Magma Mine Road (NFS Road 469)
- SR 79, between U.S. 60 and the MARRCO Railroad Line
- Skyline Drive, east of Quail Run Lane
- Skyline Drive, between Sierra Vista Drive and Schnepf Road
- Schnepf Road, between Skyline Drive and Hash Knife Draw Road
- Schnepf Road, between Hash Knife Draw Road and Combs Road
- Florence-Kelvin Highway, east of Peg Leg Road
- Florence-Kelvin Highway, east of SR 177
- SR 177, north and south of Florence-Kelvin Highway

Background Level of Service

Resolution Copper conducted an operational analysis of the existing intersections for the weekday peak hour using the nationally accepted methodology set forth in the "Highway Capacity Manual" (Transportation Research Board 2000), and using operational analysis computer software Synchro 9 to calculate the LOS for individual movements, approaches, and for each intersection. In accordance with the Highway Capacity Manual procedures, LOS has been determined by estimating the average vehicular delay of the intersections and the individual intersection movements.

LOS is a qualitative measure of the traffic operations at an intersection or on a roadway segment that is ranked from LOS A (little or no congestion), to LOS F, which signifies severe congestion. ADOT considers LOS D as adequate operational LOS at both signalized and unsignalized intersections in developed areas.

Delay thresholds for a given LOS for unsignalized intersections are lower than those reported for signalized intersections. This difference between intersection control accounts for the greater variability in delay associated with unsignalized movements as well as different driver expectations associated with each type of intersection control. Drivers generally have the expectation that signalized intersections are designed to carry higher traffic volumes and therefore would experience greater delay than might otherwise be expected at an unsignalized intersection.

At unsignalized intersections, LOS is predicted/calculated for those movements which must either stop for or yield to oncoming traffic and is based on average control delay for the movement. Control delay is the portion of total delay attributed to traffic control measure, such as stop signs. The criteria for LOS at unsignalized intersections are shown in table 3.5.3-1.

Table 3.5.3-1. Level of service criteria for unsignalized intersections

LOS Rank	Delay Threshold
A	≤ 10 seconds
B	10 seconds to ≤ 15 seconds
C	15 seconds to ≤ 25 seconds
D	25 seconds to ≤ 35 seconds
E	35 seconds to ≤ 50 seconds
F	> 50 seconds

Existing, or background, LOS were calculated for the study intersections. The resulting delay and associated LOS for each intersection are detailed in table 3.5.3-2.

All intersections in the analysis area currently operate with a LOS C or better for all movements during the peak hour under current conditions.

3.5.4 Environmental Consequences of Implementation of the Proposed Mine Plan and Alternatives

3.5.4.1 Alternative 1 – No Action

Traffic Volume/Level of Service

Under the no action alternative, no mine expansion would occur and the existing transportation patterns and existing infrastructure in the analysis area would continue. Traffic volumes are expected to continue to increase at an average 2 percent annual growth rate over the next 10 to 20 years, resulting in increased traffic levels on all roads in the area (Southwest Traffic Engineering LLC 2017). With increasing traffic, due to normal background growth and development of the area, the intersections in the analysis area are generally expected to operate within an acceptable LOS in the peak construction and operation years 2022 and 2027 (see table 3.5.4-3 later in this section). The Combs Road/Schnepf Road intersection is expected to operate with a side street LOS E/F by year 2022 through 2027. A traffic signal may be required at this intersection, along with exclusive turn lanes for all approaches, to alleviate delays expected to occur with or without the project.

Transportation Routes

Under the no action alternative, existing transportation routes would not change. There would be no direct, indirect, or cumulative effects on the transportation routes as a result.

Changes in Access

Public access to NFS land and transportation infrastructure would not be impacted under the no action alternative because there would be no new roads, updates to existing roads, or closures of existing roads under this alternative. There would be no direct, indirect, or cumulative effects on changes in access as a result.

3.5.4.2 Impacts Common to All Action Alternatives

Effects of the Land Exchange

The land exchange would have significant effects on transportation and access. The Oak Flat Federal Parcel would leave Forest Service jurisdiction, and with it public access would be lost to the parcel itself, as well as passage through the parcel to other destinations, including Apache Leap and Devil's Canyon. These locations have other means of access, but those routes may not be as direct or convenient. Resolution Copper may keep portions of the property open for public access, as feasible.

The offered land parcels would enter either Forest Service or BLM jurisdiction. The eight parcels would have beneficial effects; they would become accessible by the public and be managed by the Federal Government for multiple uses. Roads and access would be managed in accordance with the appropriate management plans and agency direction.

Table 3.5.3-2. Existing peak hour level of service and delay

Intersection	Peak Hour	
	LOS Rank	**Delay (seconds)**
Combs Road/Schnepf Road		
Eastbound Left	C	18.9
Eastbound Through/Right	C	15.6
Westbound Left	B	11.4
Westbound Through/Right	B	11.3
Northbound Left	C	15.6
Northbound Through/Right	B	11.6
Southbound Left	B	10.5
Southbound Through/Right	C	24.9
Skyline Drive/Sierra Vista Drive		
Eastbound Left/Through	A	7.7
Southbound Left/Right	A	9.9
Skyline Drive/Quail Run Lane		
Eastbound Left/Through/Right	A	8.1
Westbound Left/Through/Right	A	7.8
Northbound Left/Through/Right	A	8.6
Southbound Left/Through/Right	A	7.4
Hewitt Station Road (NFS Road 357)/Westbound U.S. 60		
Northbound Left/Through	A	0.0
Southbound Through/Right	A	0.0
Hewitt Station Road (NFS Road 357)/Eastbound U.S. 60		
Southbound Left	A	0.0
Silver King Mine Road (NFS Road 229)/U.S. 60		
Eastbound Left	A	0.0
Westbound Left	A	8.4
Northbound Left/Through/Right	C	15.4
Southbound Left/Through/Right	B	14.7
Main Street/Lonetree Road		
Eastbound Left	A	7.3

continued

Table 3.5.3-2. Existing peak hour level of service and delay *(cont'd)*

Intersection	Peak Hour	
	LOS Rank	**Delay (seconds)**
Southbound Left/Right	A	8.8
Main Street/U.S. 60		
Eastbound Left/Through	A	8.8
Southbound Left	C	24.0
Southbound Right	B	12.7
Main Street/Magma Avenue		
Eastbound Left/Through/Right	A	7.4
Westbound Left/Through/Right	A	7.7
Northbound Left/Through/Right	A	7.9
Southbound Left/Through/Right	A	7.5
Heiner Street/Ray Road/Westbound U.S. 60 Off Ramp		
Eastbound Left/Right	A	9.4
Westbound Left/Through/Right	A	9.6
Northbound Left/Through	A	7.5
SR 177/Eastbound U.S. 60 Ramps		
Eastbound Left/Through/Right	A	9.6
Southbound Left/Through	A	7.6
Magma Mine Road (NFS Road 469)/U.S. 60		
Eastbound Left	A	0.0
Westbound Left	A	7.9
Northbound Left/Through/Right	C	16.8
Southbound Left/Through/Right	A	0.0
Florence-Kelvin Highway/SR 79		
Westbound Left/Right	A	9.8
Southbound Left	A	7.8
Florence-Kelvin Highway/SR 177		
Eastbound Left/Right	A	9.1
Northbound Left/Through	A	7.5

continued

Table 3.5.3-2. Existing peak hour level of service and delay *(cont'd)*

	Peak Hour	
Intersection	**LOS Rank**	**Delay (seconds)**
Dripping Springs Road/SR 77		
Eastbound Left/Right	A	9.1
Northbound Left/Through	A	7.4

Effects of Forest Plan Amendment

The Tonto National Forest Land and Resource Management Plan (1985b) provides guidance for management of lands and activities within the Tonto National Forest. It accomplishes this by establishing a mission, goals, objectives, and standards and guidelines. Missions, goals, and objectives are applicable on a forest-wide basis. Standards and guidelines are either applicable on a forest-wide basis or by specific management area.

A review of all components of the 1985 forest plan was conducted to identify the need for amendment due to the effects of the project, including both the land exchange and the proposed mine plan (Shin 2019). A number of standards and guidelines (12) were identified applicable to management of transportation and access. None of these standards and guidelines were found to require amendment to the proposed project, either on a forest-wide or management area-specific basis. For additional details on specific rationale, see Shin (2019).

Summary of Applicant-Committed Environmental Protection Measures

A number of environmental protection measures are incorporated into the design of the project that would act to reduce potential impacts on transportation and access. These are non-discretionary measures and their effects are accounted for in the analysis of environmental consequences.

The GPO (Resolution Copper 2016d) outlined applicant-committed environmental protection measures by Resolution Copper in Appendix K, "Road Use Plan:"

- Public access to the lands in the vicinity of the East Plant Site would be maintained via SR 177 and NFS Road 315 as well as U.S. 60 and NFS Road 469 (until access is no longer possible).
- A number of best management practices for road construction and maintenance were identified in the GPO:
    - To the extent practicable, vegetation will not be removed except from those areas to be directly affected by road reconstruction activities.
    - Cut-and-fill slopes for road reconstruction will be designed to prevent soil erosion.
    - Drainage ditches with cross drains will be constructed where necessary. Disturbed slopes will be revegetated, mulched, or otherwise stabilized to minimize erosion as soon as practicable following construction.
    - Road embankment slopes will be graded and stabilized with vegetation or rock as practicable to prevent erosion.
    - Runoff from roads will be handled through best management practices, including sediment traps, settling ponds, berms, sediment filter fabric, wattles, etc. Design of these features will be based on an analysis of local hydrologic conditions.

  - Off-road vehicle travel will generally be avoided.
  - During construction and operations, diversions will be constructed around affected areas to minimize erosion. A number of best management practices including check dams, dispersion terraces, and filter fences also will be used during construction and operations.
- Specific NFS road improvements and maintenance are also specified in the GPO; these are summarized here together with known impacts on NFS roads. The GPO notes several replacement roads that provide periphery access around the tailings facility; these roads are anticipated to be located within the fence line that excludes public access and therefore these roads are not considered to replace any through-access lost from the tailings facility.
- Realignment of NFS Road 229/Silver King Mine Road is envisioned under all alternatives. The physical disturbance from this realignment is incorporated into the assessment of impacts. Note that under Alternatives 2, 3, 5, and 6, the realignment of Silver King Mine Road is meant to provide through-access to the highlands north of the West Plant Site. For Alternative 4 this is true as well, but the presence of the tailings facility in this area restricts through-access to administrative uses only.

Two additional measures were identified in the traffic studies as being recommended to improve LOS impacts caused by mine traffic (Southwest Traffic Engineering LLC 2017). These measures would be subject to approval by the appropriate local traffic authorities prior to implementation:

- New stop signs would be installed at minor approaches to intersections as needed and subject to appropriate approval by ADOT.
- If necessary, flaggers or officers would be used to assist with turning movements at major project intersections during peak construction, subject to appropriate approval by ADOT.
- During peak construction, construction traffic or similar advanced warning signs would be used as needed, and subject to appropriate approval by ADOT.

Mine-Related Traffic

Increased traffic associated with the mine during peak construction (2022) and normal operations (2027), includes four main traffic generators:

1. East Plant Site
2. West Plant Site
3. San Tan Valley filter plant and loadout facility
4. Tailings storage facility (four alternate locations)

There are four alternative locations for the tailings and storage facility (located at either the Near West, Silver King, Peg Leg, or Skunk Camp location), with each location having unique access roads, as shown in figure 3.5.4-1. All alternatives, except for Silver King, place the filter plant and loadout facility in the San Tan Valley. The Silver King alternative places the filter plant and loadout facility at the West Plant Site. This section focuses on the impacts that are common to all action alternatives; the impacts associated specifically with each alternative are summarized in the next sections. Table 3.5.4-1 describes the intersections that would be impacted by the East Plant Site, West Plant Site, and the San Tan Valley filter plant and loadout facility.

Transportation of personnel, equipment, supplies, and materials related to mine development, operation, and reclamation has the potential to increase traffic. Moreover, this increased traffic can impact local and regional travel patterns and intersection LOS. In addition, increased volumes of traffic are likely to contribute to earlier and more extensive deterioration of road surfaces, therefore requiring more frequent and higher levels of maintenance.

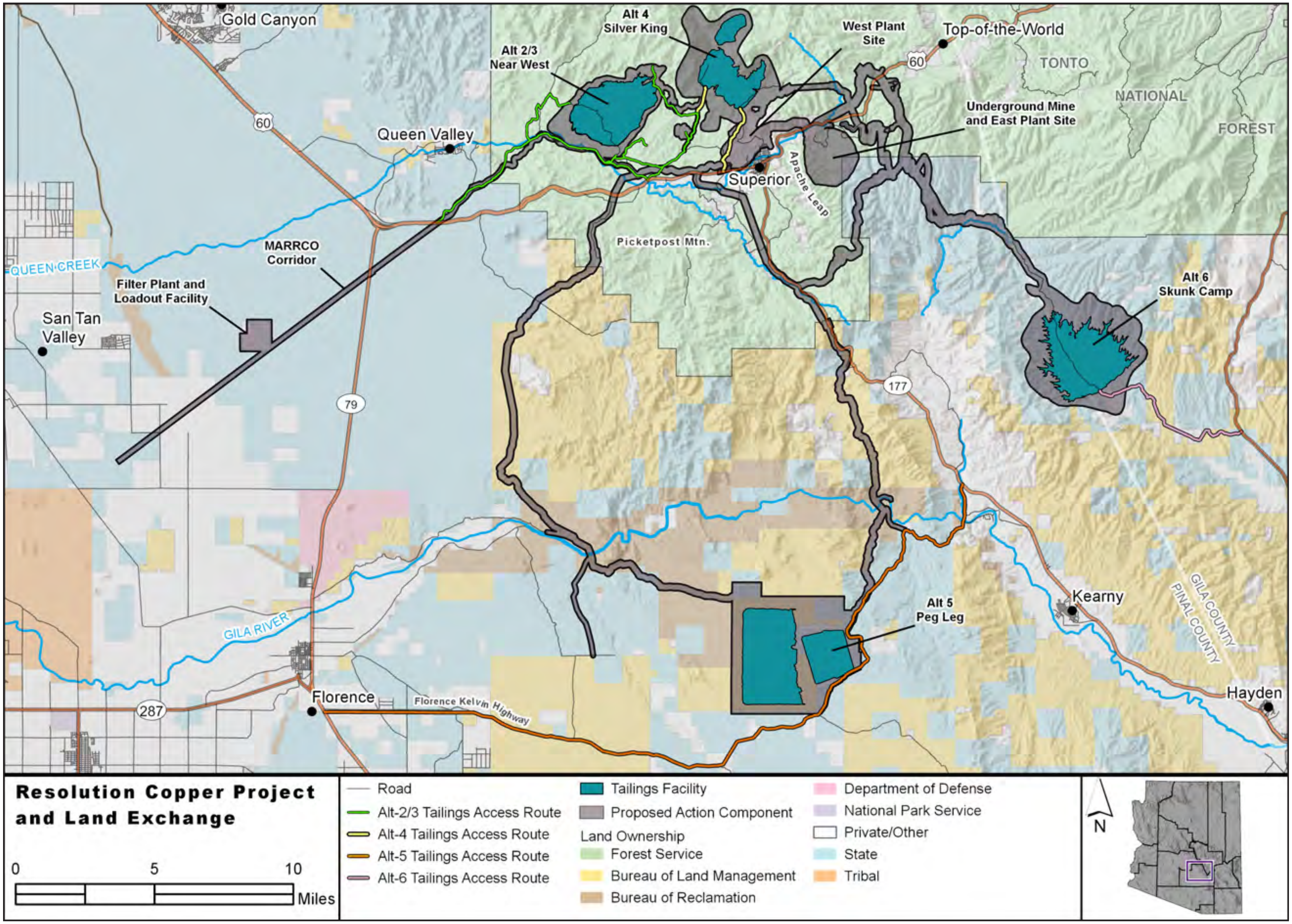


Figure 3.5.4-1. Access roads for alternative tailings storage facilities

Table 3.5.4-1. Intersections impacted by all action alternatives

Facility	Intersections Impacted
East Plant Site	U.S. 60 and Magma Mine Road
West Plant Site	Main Street and Magma Avenue Main Street and Lonetree Road Main Street and U.S. 60 Heiner Street/Ray Road/Westbound U.S. 60 off-ramp SR 177 and eastbound U.S. 60 ramps U.S. 60 and Silver King Mine Road U.S. 60 and Hewitt Station Road
San Tan Valley filter plant and loadout facility (except Silver King alternative)	Skyline Drive and Sierra Vista Drive Skyline Drive and Quail Run Road Schnepf Road and Combs Road

Table 3.5.4-2. Site-generated trips during peak hour

	Peak Construction		Normal Operations	
Facility	Employee Trips	Material/ Equipment Trips	Employee Trips	Material/ Equipment Trips
East Plant Site	438	22	332	22
West Plant Site	1,038	22	336	22
San Tan Valley filter plant and loadout facility	60	16	18	0

Note: Peak hour employee and material/equipment trips are assumed to be 50 percent inbound, 50 percent outbound

Typical road maintenance and repair activities of paved roads due to increased traffic flows include more frequent asphalt resealing, patching, and pothole repair, line repainting, overlay work, and, eventually, complete pavement reconstruction. At present, the costs due to increased mine-related traffic of these activities would be borne solely by the Town of Superior, Pinal County, or ADOT, depending on the particular roadway segment. Please see Section 3.13, Socioeconomics, for a more detailed discussion of the economic effects of increased traffic in the vicinity of the Resolution Copper Project.

Table 3.5.4-2 shows the total number of trips expected during the peak hour during peak construction and normal operations (50 percent of trips are assumed to be inbound and 50 percent outbound during the peak hour). There are 1,596 trips expected in the peak hour during construction and 730 trips in the peak hour during normal operations. In general, traffic impacts are more significant during peak construction than operations, as there are more employee commute trips.

The analysis includes assumptions designed to estimate peak hour employee trips based on the number of employees working at each facility:

- There would be several different employee types and shift times/lengths at the mining facilities. A shift reduction factor of 0.66 was applied to estimate the number of employees traveling to/from the site during the peak hour.
- It was assumed that half of the employees would arrive, and half depart, during the peak hour.
- To factor in employee carpooling, it was assumed that each vehicle entering the site would carry an average of 1.7 employees.

Traffic Volume and Level of Service

Table 3.5.4-3 shows the delay and LOS for each intersection movement, with and without the project, during peak construction (year 2022) and

normal operations (year 2027). A 2 percent annual growth rate was used to estimate projected background traffic volumes in years 2022 and 2027 (Southwest Traffic Engineering LLC 2017).

With increasing traffic, due to normal background growth and development of the area, the intersections in the analysis area are generally expected to operate within an acceptable LOS in years 2022 and 2027 for most intersections (see table 3.5.4-3). Project-related traffic would contribute to decreased LOS at many intersections, but only the following have LOS degraded to LOS E/F status:

- The Combs Road/Schnepf Road intersection, southbound, degrades from LOS E to LOS F; this occurs under the no action alternative as well.
- The Silver King Mine Road/U.S. 60 intersection, northbound, degrades from LOS C to LOS F during construction, and to LOS E during operations. The southbound lanes degrade from LOS C to LOS F during construction, and LOS D during operations.
- The Main Street/U.S. 60 intersection, southbound, degrades from LOS C to LOS F during construction and operations.
- The SR 177/U.S. 60 intersection, eastbound, degrades from LOS A to LOS E during construction.
- The Magma Mine Road/U.S. 60 intersection, northbound, degrades from LOS C to LOS F during operations.

Transportation Routes and Changes in Access

Changes in access to the NFS road system as a result of the proposed activities at the East Plant Site, West Plant Site, and filter plant and loadout facility are shown in table 3.5.4-4. Approximately 8.0 miles of NFS roads are expected to be decommissioned or lost.

The primary impacts occur from the subsidence area development and include large portions of NFS Roads 315 and 3153. These roads provide access to areas that include Apache Leap and Devil's Canyon as well as connectivity to other NFS roads. Access would still be available to these areas, but those routes may not be as direct or convenient. Resolution Copper may keep portions of the property open for public access, as feasible, but the roads that pass through the Oak Flat Federal Parcel are not expected to remain open.

All alternatives would involve impacts on Silver King Mine Road and NFS Road 229, which provide through travel to the highlands north of Superior, as well as to private inholdings in the Tonto National Forest. All alternatives would maintain access to these areas; for Alternative 4, access would be administrative due to the presence of the tailings storage facility.

Railroads

Increased rail traffic along the MARRCO corridor associated with the mine has the potential to impact traffic patterns in the local area. All alternatives involve use of the MARRCO corridor from the San Tan Valley filter plant and loadout facility to the main rail line. Alternative 4 – Silver King requires approximately two trains per day during peak operations to deliver materials along the MARRCO corridor from the West Plant Site to the main rail line. The trains are expected to arrive and depart during the night shift. Due to their overnight operations, the trains are expected to be inconsequential to the operations of the road network.

For safety purposes, it is recommended that Resolution Copper work with ADOT to update signage at highway and NFS road/railroad-grade crossings.

3.5.4.3 Alternative 2 and Alternative 3 – Near West

Mine-Related Traffic

Table 3.5.4-5 summarizes the facility footprint and intersections impacted by mine-related traffic at each tailings storage facility alternative. For Alternatives 2 and 3, the tailings storage facility is

Table 3.5.4-3. Level of service and delay during peak construction (2022) and normal operations (2027)

Intersection	2022 without Project LOS	2022 without Project Delay (seconds)	2022 with Project LOS	2022 with Project Delay (seconds)	2027 without Project LOS	2027 without Project Delay (seconds)	2027 with Project LOS	2027 with Project Delay (seconds)
Combs Road/Schnepf Road								
Eastbound Left	C	24.8	D	25.9	D	31.5	D	31.8
Eastbound Through/Right	C	20.4	C	24.9	D	25.4	D	26.7
Westbound Left	B	12.1	B	12.3	B	12.3	B	12.4
Westbound Through/Right	B	12.3	B	12.6	B	12.8	B	12.9
Northbound Left	C	18.5	C	21.8	C	21.0	C	21.8
Northbound Through/Right	B	12.7	B	12.9	B	13.4	B	13.5
Southbound Left	B	11.1	B	11.3	B	11.5	B	11.5
Southbound Through/Right	**E**	42.4	**E**	47.1	**F**	67.5	**F**	67.7
Skyline Drive/Sierra Vista Drive								
Eastbound Left/Through	A	7.7	A	7.8	A	7.9	A	7.9
Southbound Left/Right	B	10.1	B	10.4	B	10.6	B	10.7
Skyline Drive/Quail Run Lane								
Eastbound Left/Through/Right	A	8.5	A	9.1	A	8.8	A	8.9
Westbound Left/Through/Right	A	8.0	A	8.4	A	8.1	A	8.2
Northbound Left/Through/Right	A	9.0	A	9.4	A	9.3	A	9.4
Southbound Left/Through/Right	A	7.6	A	7.9	A	7.7	A	7.8
Hewitt Station Road (NFS Road 357)/Westbound U.S. 60								
Northbound Left/Through	A	0.0	A	0.0	A	0.0	A	0.0
Southbound Through/Right	A	0.0	C	15.7	A	0.0	B	12.6
Hewitt Station Road (NFS Road 357)/Eastbound U.S. 60								
Southbound Left	A	0.0	A	0.0	A	0.0	A	0.0
Silver King Mine Road (NFS Road 229)/U.S. 60								
Eastbound Left	A	9.2	B	13.1	A	9.5	B	11.0
Westbound Left	A	8.6	B	11.2	A	8.8	A	9.9
Northbound Left/Through/Right	C	18.6	**F**	>120	C	20.9	**E**	45.4
Southbound Left/Through/Right	C	17.8	**F**	105.7	C	19.4	D	33.1

continued

Table 3.5.4-3. Level of service and delay during peak construction (2022) and normal operations (2027) *(cont'd)*

Intersection	2022 without Project LOS	2022 without Project Delay (seconds)	2022 with Project LOS	2022 with Project Delay (seconds)	2027 without Project LOS	2027 without Project Delay (seconds)	2027 with Project LOS	2027 with Project Delay (seconds)
Main Street/Lonetree Road								
Eastbound Left	A	7.4	A	8.1	A	7.4	A	7.6
Southbound Left/Right	A	8.9	C	15.3	A	8.9	A	9.8
Main Street/U.S. 60								
Eastbound Left/Through	A	9.1	C	15.9	A	9.5	B	11.5
Southbound Left	C	23.3	**F**	>120	D	27.2	**F**	70.1
Southbound Right	B	10.9	D	26.3	B	11.3	B	14.6
Main Street/Magma Avenue								
Eastbound Left/Through/Right	A	7.6	B	11.5	A	7.9	A	8.1
Westbound Left/Through/Right	A	7.8	B	10.8	A	8.1	A	8.2
Northbound Left/Through/Right	A	8.0	D	25.6	A	8.4	A	8.8
Southbound Left/Through/Right	A	7.7	C	19.7	A	7.9	A	8.3
Heiner Street/Ray Road/Westbound U.S. 60 Off-Ramp								
Eastbound Left/Right	A	9.6	C	17.1	A	9.7	B	10.2
Westbound Left/Through/Right	A	9.9	B	13.5	A	9.9	B	10.4
Northbound Left/Through	A	7.6	A	8.7	A	7.6	A	7.7
SR 177/Eastbound U.S. 60 Ramps								
Eastbound Left/Through/Right	A	9.8	**E**	43.5	B	10.0	B	11.1
Southbound Left/Through	A	7.7	A	8.0	A	7.7	A	7.8
Magma Mine Road (NFS Road 469)/U.S. 60								
Eastbound Left	A	0.0	A	0.0	A	0.0	A	0.0
Westbound Left	A	8.0	A	8.3	A	8.1	A	8.2
Northbound Left/Through/Right	C	19.3	D	31.0	C	21.9	**F**	>120
Southbound Left/Through/Right	A	0.0	A	0.0	A	0.0	A	0.0

Note: Shaded cells indicate an LOS of E or F, which is considered inadequate by ADOT

Table 3.5.4-4. Miles of NFS roads decommissioned and lost for East Plant Site, West Plant Site, and filter plant and loadout facility

Facility	Tonto National Forest NFS Roads Decommissioned and Lost (miles)*	Resolution Copper Applicant-Committed Improvements and Maintenance
West Plant Site: Total Roads	2.54	
NFS Road 1010	0.37	Level 1
NFS Road 229	2.17	Portions reconstructed to level 3
East Plant Site/Subsidence Area: Total Roads	5.45	
NFS Road 2432	0.78	None
NFS Road 2433	0.23	None
NFS Road 2434	0.29	None
NFS Road 2435	0.28	None
NFS Road 2438	0.32	None
NFS Road 3153	1.19	None
NFS Road 3791	0.1	None
NFS Road 315	2.28	None
San Tan Valley Filter Plant and Loadout Facility: Total Roads	0.0	None

Notes: Roads intersected by pipeline corridors or transmission line corridors are considered to remain open.

Level 1 – Basic custodial care; Level 2 – High-clearance vehicles; Level 3 – Suitable for passenger cars

* Includes West Plant Site, East Plant Site, subsidence area, and maximum impact acreage for Silver King Mine Road alignment. Road segments less than 0.05 mile not shown.

Table 3.5.4-5. Footprint and intersections impacted by each tailings storage facility location

Alternative	Footprint within Tailings Storage Facility Fence Line (acres)	Intersections Impacted by Traffic
Alternatives 2 and 3 – Near West	4,903	U.S. 60 and Hewitt Station Road
Alternative 4 – Silver King	5,661	U.S. 60 and Silver King Mine Road
Alternative 5 – Peg Leg	10,782	SR 79 and Florence-Kelvin Highway SR 177 and Florence-Kelvin Highway Florence-Kelvin Highway and Peg Leg Road
Alternative 6 – Skunk Camp	8,647	SR 77 and Dripping Springs Road

located at the same site and the traffic impacts are the same; therefore, the results for these two alternatives have been grouped together.

Table 3.5.4-6 shows the total number of trips expected during the peak hour for each alternative (50 percent of trips are assumed to be inbound and 50 percent outbound during the peak hour). Alternatives 2 and 3 involve 64 trips in the peak hour during construction and 46 trips in the peak hour during normal operations.

Traffic Volume and Level of Service

Table 3.5.4-7 shows the delay and LOS for each alternative, with and without the project, during peak construction (year 2022) and normal operations (year 2027).

For Alternatives 2 and 3, the intersections adjacent to the tailings storage facility alternatives are expected to continue operating at an adequate LOS during both peak construction and normal operations. No right- or left-turn lanes are required at the study intersections providing access to the tailings storage facility alternatives.

Table 3.5.4-6. Site-generated trips during peak hour for each alternative

Alternative	Peak Construction		Normal Operations	
	Employee Trips	Material/ Equipment Trips	Employee Trips	Material/ Equipment Trips
Alternatives 2 and 3 – Near West	42	22	24	22
Alternative 4 – Silver King	66	22	36	22
Alternative 5 – Peg Leg	44	22	24	22
Alternative 6 – Skunk Camp	42	22	24	22

Note: Peak hour employee and material/equipment trips are assumed to be 50% inbound, 50% outbound.

Transportation Routes and Changes in Access

Mine development has the potential to permanently alter, add, or decommission NFS roads or temporarily restrict access to NFS roads and lands, which could impact forest users and permittees. Some roads cut off by the perimeter fence would result in dead-end conditions. Ongoing and future travel management planning would determine which, if any, of these dead-end roads should be closed or decommissioned. These new conditions would result in site-specific and user-specific impacts, depending upon an individual's preference for using an NFS road.

Under all action alternatives, public access would not be allowed on any roads within the perimeter fence for security purposes and in order to protect public health and safety. This may conflict with the ongoing travel management goals of maintaining NFS roads for public use to the degree reasonable. All NFS roads and unauthorized roads on NFS land within the perimeter fence or roads on NFS land outside the perimeter fence that would no longer be accessible would be either decommissioned, rerouted to connect to another road, changed to administrative-only access, or have a turnaround constructed near the perimeter fence. Roadway decommissioning details would be developed by the Forest Service when the time for permanent closure is closer and more information is available. The NFS roads expected to be decommissioned or otherwise lost to public access for Alternatives 2 and 3 are shown in table 3.5.4-8.

Approximately 21.7 miles of NFS roads are expected to be decommissioned or lost. The roads impacted by the tailings storage facility are largely local to the tailings area and one route does provide through travel to other areas of the Tonto National Forest. Access would still be available to these areas but those routes may not be as direct or convenient.

All NFS roads that would be used by Resolution Copper and also remain open to the public would be maintained by Resolution Copper, and road improvements would be made when needed to maintain public safety. Table 3.5.4-9 describes the disturbance from new access roads associated with each alternative.

3.5.4.4 Alternative 4 – Silver King

Mine-Related Traffic

Table 3.5.4-5 summarizes the facility footprint and intersections impacted by mine-related traffic at each tailings storage facility alternative. Table 3.5.4-6 shows the total number of trips expected during the peak hour for each alternative (50 percent of trips are assumed to be inbound and 50 percent outbound during the peak hour). Alternative 4 involves 88 trips in the peak hour during construction and 58 trips in the peak hour during normal operations. Alterative 4 is unique in that it also involves relocating the filter plant and loadout facility from San Tan Valley to the West Plant Site. Thus, more employees are needed for the Silver King alternative than the other alternatives. In general, more employees are needed during peak construction than normal operations.

Table 3.5.4-7. Level of service and delay for tailings storage facility alternate locations during peak construction (2022) and normal operations (2027)

		2022 without Project		2022 with Project		2027 without Project		2027 with Project	
Alternative	**Intersection**	**LOS**	**Delay (seconds)**	**LOS**	**Delay (seconds)**	**LOS**	**Delay (seconds)**	**LOS**	**Delay (seconds)**
Alternatives 2 and 3 – Near West Location	**Hewitt Station Road (NFS Road 357)/Eastbound U.S. 60**								
	Northbound Through/Right	A	0.0	A	0.0	A	0.0	A	0.0
	Southbound Left/Through	B	10.6	B	11.3	B	10.9	B	11.4
	Hewitt Station Road (NFS Road 357)/Westbound U.S. 60								
	Northbound Left/Through	C	15.1	C	15.6	C	15.5	C	16.4
	Southbound Through/Right	B	13.7	B	12.1	B	13.9	B	12.9
Alternative 4 – Silver King Location	**Silver King Mine Road (NFS Road 229)/U.S. 60**								
	Eastbound Left	A	9.2	A	9.4	A	9.5	A	9.7
	Westbound Left	A	8.7	A	8.7	A	8.9	A	8.9
	Northbound Left/Through/Right	C	20.4	C	24.2	C	24.6	D	27.7
	Southbound Left/Through/Right	C	19.6	C	19.4	C	23.9	C	22.7
Alternative 5 – Peg Leg Location	**Florence- Kelvin Highway/SR 79**								
	Westbound Left/Right	B	10.1	B	10.4	B	10.4	B	10.6
	Southbound Left	A	7.9	A	7.9	A	7.9	A	8.0
	Florence-Kelvin Highway/SR 177								
	Eastbound Left/Right	A	9.3	A	9.9	A	9.5	A	9.9
	Northbound Left/Through	A	7.6	A	7.6	A	7.6	A	7.6
	Florence-Kelvin Highway/ Peg Leg Road								
	Eastbound Left/Right	n/a	n/a	A	8.8	n/a	n/a	A	8.7
	Northbound Left/Through	n/a	n/a	A	7.3	n/a	n/a	A	7.3
Alternative 6 – Skunk Camp Location	**Dripping Springs Road/SR 77**								
	Eastbound Left/Right	A	9.1	A	9.8	A	9.4	A	9.8
	Northbound Left/Through	B	7.4	A	7.4	A	7.4	A	7.5

Table 3.5.4-8. Miles of NFS roads decommissioned and lost for Alternatives 2 and 3 tailings storage facility

Facility	Tonto National Forest NFS Roads Decommissioned and Lost (miles)	Resolution Copper Applicant-Committed Improvements and Maintenance
Alternatives 2 and 3 – Near West: Total Roads*	21.70	
NFS Road 2386	0.20	Portions restored to level 1
NFS Road 1903	2.68	None
NFS Road 1907	1.82	None
NFS Road 1909	0.36	None
NFS Road 1910	0.41	None
NFS Road 1912	0.54	None
NFS Road 1913	0.29	None
NFS Road 1914	0.29	None
NFS Road 1915	0.39	None
NFS Road 1916	0.22	None
NFS Road 1917	0.40	None
NFS Road 1918	0.23	None
NFS Road 1919	0.40	None
NFS Road 2359	2.22	None
NFS Road 2360	1.33	None
NFS Road 2361	0.37	None
NFS Road 2362	0.31	None
NFS Road 2363	0.37	None
NFS Road 2364	0.59	None
NFS Road 2366	0.05	None
NFS Road 2380	0.96	None
NFS Road 252	3.36	Portions reconstructed to level 2
NFS Road 3450	0.26	None
NFS Road 518	2.41	None
NFS Road 982	1.10	Portions reconstructed to level 2
NFS Road 3455	0.08	None
NFS Road 357	0.06	Maintained (level not specified)

Note: Level 1 – Basic custodial care; Level 2 – High-clearance vehicles; Level 3 – Suitable for passenger cars
* Includes tailings facility (within fence line) and borrow area footprints; does not include pipeline or transmission line corridors, which are assumed to allow roads to remain open. Road segments less than 0.05 miles not shown.

Table 3.5.4-9. New access roads for tailings storage facility alternatives

Alternative	New Access Roads
Alternatives 2 and 3 – Near West	This alternative would include rerouting Silver King Mine Road (NFS Road 229) to maintain through-access.
Alternative 4 – Silver King	This alternative involves rerouting of Silver King Mine Road for deliveries to the West Plant Site. The new access road would be about 1 mile in length. The new access road reduces the use of Silver King Mine Road (NFS Road 229) to 0.4 mile, but infrequent use along NFS Road 229, north of the MARRCO corridor would continue for accessing the SRP substation.
Alternative 5 – Peg Leg	This alternative would include rerouting Silver King Mine Road (NFS Road 229) to maintain through-access. Most access roads would follow existing routes. However, some new access roads would be needed along the tailings conveyance pipeline corridor. There are two alignments under consideration for the pipeline corridor. Additional access roads for the western alignment would include 5.1 miles or 12.4 acres of new disturbance. Additional access roads for the eastern alignment would include 2.2 miles or 5.3 acres of new disturbance.
Alternative 6 – Skunk Camp	This alternative would include rerouting Silver King Mine Road/ NFS Road 229 to maintain through access. New access roads would be needed along the tailings conveyance pipeline corridor. There are two alignment options under consideration for the pipeline corridor. In summary, 4 miles of access roads are needed for the north option, and 6 miles of access roads are needed for the south option. In addition, 20 miles of new access roads are needed along a separate power line corridor.

Traffic Volume and Level of Service

Table 3.5.4-7 shows the delay and LOS for each alternative, with and without the project, during peak construction (year 2022) and normal operations (year 2027). For Alternative 4, the intersections adjacent to the tailings storage facility alternatives are expected to continue operating at an adequate LOS during both peak construction and normal operations.

Tranportation Routes and Changes in Access

The NFS roads expected to be decommissioned or otherwise lost to public access for Alternative 4 are shown in table 3.5.4-10.

Approximately 17.7 miles of NFS roads are expected to be decommissioned or lost. The roads impacted by the tailings storage facility provide through-travel to other areas of the Tonto National Forest, including some recreation loops and private inholdings (including Silver King Mine). Access would still be available to the recreation areas but those routes may not be as direct or convenient. Administrative access would be maintained on NFS Road 229 in order to provide through-travel to private inholdings.

All NFS roads that would be used by Resolution Copper and also remain open to the public would be maintained by Resolution Copper, and road improvements would be made when needed to maintain public safety. Table 3.5.4-10 describes the disturbance from new access roads associated with each alternative.

3.5.4.5 Alternative 5 – Peg Leg

Mine-Related Traffic

Table 3.5.4-5 summarizes the facility footprint and intersections impacted by mine-related traffic at each tailings storage facility alternative. Table 3.5.4-6 shows the total number of trips expected during the peak hour for each alternative (50 percent of trips are assumed to be inbound and 50 percent outbound during the peak hour). Alternative 5

involves 66 trips in the peak hour during construction and 46 trips in the peak hour during normal operations.

Traffic Volume and Level of Srevice

Table 3.5.4-7 shows the delay and LOS for each alternative, with and without the project, during peak construction (year 2022) and normal operations (year 2027). For Alternative 5, the intersections adjacent to the tailings storage facility alternatives are expected to continue operating at an adequate LOS during both peak construction and normal operations.

Transporation Routes and Changes in Access

Alternative 5 would not result in the loss or decommissioning of any additional NFS roads due to the tailings storage facility. BLM estimates that the Alternative 5 footprint would directly affect approximately 29 miles of inventoried routes, with additional indirect effects from through disruption of existing routes. The BLM land in the area is designated under off-highway vehicle (OHV) regulations as "Limited to Existing Roads and Trails." The area includes existing primitive roads and trails, and the tailings facility would cause the loss of access and disrupt the continuity of existing routes. BLM also has identified potential loss of access to mining activities and grazing facilities as concerns for Alternative 5.

3.5.4.6 Alternative 6 – Skunk Camp

Mine-Related Traffic

Table 3.5.4-5 summarizes the facility footprint and intersections impacted by mine-related traffic at each tailings storage facility alternative. Table 3.5.4-6 shows the total number of trips expected during the peak hour for each alternative (50 percent of trips are assumed to be inbound and 50 percent outbound during the peak hour). Alternative 5 involves 64 trips in the peak hour during construction and 46 trips in the peak hour during normal operations.

Traffic Volume and Level of Servce

Table 3.5.4-7 shows the delay and LOS for each alternative, with and without the project, during peak construction (year 2022) and normal operations (year 2027). For Alternative 6, the intersections adjacent to the tailings storage facility alternatives are expected to continue operating at an adequate LOS during both peak construction and normal operations.

Transportation Routes and Changes in Access

Alternative 6 would be located on private lands (after assumed acquisition of State Trust lands) and would impact 5.7 miles of Dripping Springs Road. BLM has identified the potential loss of access to mining activities and grazing facilities as concerns for Alternative 6.

3.5.4.7 Cumulative Effects

The Tonto National Forest identified the following reasonably foreseeable future actions as likely, in conjunction with development of the Resolution Copper Mine, to contribute to cumulative impacts on transportation and access, which may include impacts on the roads adjacent to the proposed mine, roads that would provide regional access to the proposed mine and its facilities, roads within or cut off by the perimeter fence that would be inaccessible to the public from mine activities, and the proposed primary access roads and utility maintenance roads (see figure 3.5.4-1). As noted in section 3.1, past and present actions are assessed as part of the affected environment; this section analyzes the effects of any RFFAs, to be considered cumulatively along with the affected environment and Resolution Copper Project effects.

- *Pinto Valley Mine Expansion.* The Pinto Valley Mine is an existing open-pit copper and molybdenum mine located approximately 8 miles west of Miami, Arizona, in Gila County. Pinto Valley Mining Corporation is proposing to expand mining activities onto an estimated 1,011 acres of new disturbance (245 acres on Tonto National Forest land and 766 acres on private

Table 3.5.4-10. Miles of NFS roads decommissioned and lost for Alternative 4 tailings storage facility

Facility	Tonto National Forest NFS Roads Decommissioned and Lost (miles)*	Resolution Copper Applicant-Committed Improvements and Maintenance
Alternative 4 – Silver King: Total Roads	17.70	
NFS Road 229	1.97	Portions reconstructed to level 3
NFS Road 1010	0.32	None
NFS Road 1053	1.46	None
NFS Road 2358	0.22	None
NFS Road 2371	0.38	None
NFS Road 2374	0.78	None
NFS Road 2375	0.41	None
NFS Road 2386	0.20	Portions restored to level 1
NFS Road 2389	0.82	None
NFS Road 2442	0.39	None
NFS Road 2443	0.12	None
NFS Road 2444	0.18	None
NFS Road 2445	0.61	None
NFS Road 2446	0.14	None
NFS Road 2447	0.65	None
NFS Road 2448	1.18	None
NFS Road 2449	0.25	None
NFS Road 2450	0.06	None
NFS Road 2451	0.12	None
NFS Road 2452	1.43	None
NFS Road 3152	0.55	Portions reconstructed to level 3
NFS Road 3787	0.14	None
NFS Road 650	3.62	None†
NFS Road 982	1.70	None†

Note: Level 1 – Basic custodial care; Level 2 – High-clearance vehicles; Level 3 – Suitable for passenger cars
* Includes tailings facility (within fence line) and borrow area footprints; does not include pipeline or transmission line corridors, which are assumed to allow roads to remain open. Road segments less than 0.05 miles not shown.
† The GPO indicates reconstruction of portions of these roads to level 2, but those actions were specific to the tailings storage facility at the Near West location.

land owned by Pinto Valley Mining Corporation) and extend the life of the mine to 2039. Impact analysis for the EIS is still pending; however, it is reasonable to expect that continued mine operations would contribute to heavy haul truck traffic along U.S. 60 and other roadways in the area, as well as vehicular traffic from mine employees, contractors, and others coming to and from the Pinto Valley Mine.

- *Ripsey Wash Tailings Project.* Mining company ASARCO is planning to construct a new tailings storage facility to support its Ray Mine operations. The environmental effects of the project were analyzed in an EIS conducted by the USACE and approved in a ROD issued in December 2018. As approved, the proposed tailings storage facility project would occupy an estimated 2,574 acres and be situated in the Ripsey Wash watershed just south of the Gila River approximately 5 miles west-northwest of Kearny, Arizona, and would contain up to approximately 750 million tons of material (tailings and embankment material). ASARCO estimates a construction period of 3 years and approximately 50 years of expansion of the footprint of the tailings storage facility as slurry tailings are added to the facility, followed by a 7- to 10-year period for reclamation and final closure. Impacts on transportation include a minor increase of approximately 115 vehicles per day along SR 177 during 3-year construction phase; during operations, only a negligible increase in project-associated vehicular traffic is anticipated. Approximately 1.4 miles of the existing, unpaved Florence-Kelvin Highway would be rerouted to the north and northeast of the tailings storage facility site and replaced with paved (asphalt) road. Cumulative effects associated with this project would be primarily related to the Alternative 5 – Peg Leg tailings storage facility location, with traffic using similar roads.
- *Silver Bar Mining Regional Landfill and Cottonwood Canyon Road*. AK Mineral Mountain, LLC, NL Mineral Mountain, LLC, POG Mineral Mountain, LLC, SMT Mineral Mountain, LLC, and Welch Mineral Mountain, LLC proposed to build a municipal solid waste landfill on private property surrounded by BLM land in an area known as the Middle Gila Canyons area. There is no way to access the proposed landfill without crossing BLM land. The owners/developers and Pinal County have applied for a BLM right-of-way grant and Temporary Use Permit for two temporary construction sites to obtain legal access to the private property and authorization of the needed roadway improvements. The proposed action includes improving a portion of the existing Cottonwood Canyon Road and a portion of the existing Sandman Road in order to accommodate two-way heavy truck traffic to and from the proposed landfill. Traffic generated by the planned landfill would significantly increase the overall annual daily traffic on Cottonwood Canyon Road. Average annual daily traffic would increase by approximately 367 percent (303 percent during winter months and 549 percent in summer). Greater safety risks may occur on this road due to the mixed use of OHVs and truck traffic to and from the proposed landfill, as the traffic generated by the landfill would primarily consist of tractor/trailer vehicles with a gross weight of over 80,000 pounds. Mineral Mountain Road and Price Road would likely be impacted by displaced traffic due to temporary closures and disruption of access on Cottonwood Canyon Road.
- *Imerys Perlite Mine*. Imerys Perlite Mine submitted a plan of operations in 2013 which included plans for continued operation of the existing sedimentation basin at the millsite; continued use of segments of NFS roads for hauling; and mining at the Forgotten Wedge and Rosemarie Exception No. 8 claims. The proposed action would have Imerys Perlite Mine continuing use of NFS Roads 229, 989, and a portion of NFS Road 2403 throughout the life of the project. Imerys would be responsible for maintaining these roads at a native-surfaced road level. Traffic to and from the millsite would occur on a regular basis.
- *Ray Land Exchange and Proposed Plan Amendment*. ASARCO is also seeking to complete a land exchange with the BLM by

which the mining company would gain title to approximately 10,976 acres of public lands and federally owned mineral estate located near ASARCO's Ray Mine in exchange for transferring to the BLM approximately 7,304 acres of private lands, primarily in northwestern Arizona. It is known that at some point ASARCO wishes to develop a copper mining operation in the "Copper Butte" area west of the Ray Mine; however, no details are currently available as to potential environmental effects, including to transportation and access, resulting from this possible future mining operation. Under the proposed action, holders and lessees of current and existing rights-of-way would negotiate directly with ASARCO regarding their status, terms, and conditions.

- *Tonto National Forest Plan Amendment and Travel Management Plan*. The Tonto National Forest is currently in the process of revising its forest plan to replace the plan now in effect, which was implemented in 1985. Simultaneously, the Tonto National Forest is developing a Supplemental EIS to address certain court-identified deficiencies in its 2016 Final Travel Management Rule EIS. Both documents and their respective implementing decisions are expected within the next 2 years. Both documents would have substantial impacts on NFS roads and transportation routes through Tonto National Forest lands. Based on the proposed travel management changes:
    - A number of routes identified for decommissioning fall within the project footprint; these would have no additional impacts when considered cumulatively with Resolution Copper Project impacts.
    - No transportation routes identified for proposed decommissioning would render invalid any alternative access routes needed to bypass project facilities.
    - Several routes proposed for decommissioning parallel proposed pipeline corridor segments. These would likely come into conflict since access roads are needed along the pipeline corridors. This occurs primarily along the Alternative 5 western pipeline corridor option.
    - No new roads proposed by Resolution Copper appear to conflict with roads proposed for decommissioning.
- *Copper King Exploratory Drilling/Superior West Exploration*. This project combines the environmental review of two mineral exploration projects proposed by Bronco Creek Exploration, Copper King, and Superior West. While Bronco Creek Exploration is the mining claimant, the exploration would be funded and bonded by Kennecott Exploration Company (part of the Rio Tinto Group), who would be the operator of record for both Plans of Operations. The combined projects result in a total of 106 unique drill site locations identified, of which the proponent would be authorized to select up to 43 to be drilled over a 10-year period. Existing roads and helicopter would be used to access drill sites. Some additional traffic would occur, but would be unlikely to cumulatively add to Resolution Copper Project impacts.
- *ADOT Vegetation Treatment*. ADOT plans to conduct annual treatments using EPA-approved herbicides to contain, control, or eradicate noxious, invasive, and native plant species that pose safety hazards or threaten native plant communities on road easements and NFS lands up to 200 feet beyond road easement on the Tonto National Forest. It can reasonably be assumed that ADOT would continue to conduct vegetation treatments along U.S. 60 on the Tonto National Forest during the expected life of the Resolution Copper Mine (50–55 years) for safety reasons. The vegetation treatment could impact motorized use along roads from additional traffic and road use, but impacts would be minimal and would be unlikely to cumulatively add to impacts from the Resolution Copper Project.
- *LEN Range Improvements*. Two actions have been proposed relating to the LEN allotment, which is a large grazing allotment in the so-called "Copper Butte" area located south of Superior between SR 177 on the east side and the White Canyon

> Wilderness on the west side; the LEN allotment is administered by the BLM Tucson Field Office. The first action would be to renew the grazing permit (#6197). The second action includes redrilling eight existing wells and drilling three new wells; equipping them with solar pumps, storage tanks, and water troughs; and performing maintenance of roads and access to the range improvements. Presently, conditions of some roads on the allotment are in disrepair and are not passable except by high-clearance four-wheel-drive vehicles. The proposed project would include minimal road maintenance and repair to allow drilling equipment into the project sites. This improvement could increase access to the area, but is not expected to be cumulative with Resolution Copper Project impacts, as none of the project disturbance is in this same area.

Other projects and plans are certain to occur or be in place during the foreseeable life of the Resolution Copper Mine (50–55 years). These, combined with general population increase and increase in recreation from mitigation measures coordinated by Resolution Copper (such as the planned outdoor recreation hub at the town of Superior, and the Recreation User Group [RUG] Plan), may cumulatively contribute to future changes to transportation use patterns in the region.

3.5.4.8 Mitigation Effectiveness

The Forest Service is in the process of developing a robust mitigation plan to avoid, minimize, rectify, reduce, or compensate for resource impacts that have been identified during the process of preparing this EIS. Appendix J contains descriptions of mitigation concepts being considered and known to be effective, as of publication of the DEIS. Appendix J also contains descriptions of monitoring that would be needed to identify potential impacts and mitigation effectiveness. As noted in chapter 2 (section 2.3), the full suite of mitigation would be contained in the FEIS, required by the ROD, and ultimately included in the final GPO approved by the Forest Service. Public comment on the EIS, and in particular appendix J, will inform the final suite of mitigation measures.

At this time, no mitigation measures have been identified that would be pertinent to transportation and access. Applicant-committed environmental protection measures have been detailed elsewhere in this section, would be a requirement for the project, and have already been incorporated into the analysis of impacts.

Unavoidable Adverse Impacts

Increased traffic associated with mine worker commuting and truck traffic to and from the mine are expected to result in impacts that cannot be avoided or fully mitigated, including increased traffic congestion and increased risk of traffic accidents. Decreases in LOS to subpar levels (LOS E or F) would occur at several intersections due to mine traffic, unless traffic changes were made to accommodate the increased traffic. The only applicant-committed environmental protection measure that would alleviate impacts on LOS would be the addition of turn lanes at the SR 177/U.S. 60 intersection.

Access to the Oak Flat area, including Devil’s Canyon and Apache Leap, would be maintained to an extent, but would use less-direct routes than NFS Road 315, which currently provides the primary access. Loss of access to these areas would be mitigated, but not fully.

Loss of access to the highlands north of the West Plant Site would be fully offset for Alternatives 2, 3, 5, and 6 by rerouting the road. Loss of access to the general public under Alternative 4 would not be mitigated by this measure, as only administrative access would be maintained.

All alternatives, including Alternative 6, could result in some loss of access to mining activities and grazing facilities in the area around the tailings storage facilities.

3.5.4.9 Other Required Disclosures

Short-Term Uses and Long-Term Productivity

Impacts from increased mine-related traffic would be short-term impacts that would cease when the mine is closed.

Irreversible and Irretrievable Commitment of Resources

Irretrievable impacts on transportation and access would occur as a result of an increase of traffic on State, County, and public NFS roads from mining and related activities within the analysis area and from the reduction of public access to roads within the perimeter fence. Because mine-related traffic would cease after mine closure, traffic impacts would not be considered an irreversible commitment of resources. Existing roads that would be decommissioned within the perimeter fence of the mine would constitute both an irreversible and irretrievable commitment of resources. Roads that are permanently covered with tailings or within the subsidence area would be an irreversible commitment, whereas those that are cut off to public access by the perimeter fence could potentially be restored or rerouted following mine closure and therefore are considered to be an irretrievable commitment of resources.

Overview

Motorized mine equipment and vehicles, potential large-scale ground surface disturbance and conveyance, and placement of mine tailings can adversely affect air quality through emissions and wind-borne particulates generated during mining operations. Short- and long-term local air quality monitoring records, as well as regional monitoring of National Ambient Air Quality Standards (NAAQS), ozone (O_3), hazardous air pollutants (HAPs), anticipated effects on visibility, and other Federal and State emissions standards are key factors that help to analyze potential project impacts. Class I and Class II sensitive areas are of specific concern.

3.6 Air Quality

3.6.1 Introduction

Air quality conditions are a valuable resource from an aesthetic and human health perspective, and they are subject to specific regulations that aim to protect that resource. Local and regional aspects of air quality may be affected by the proposed action and alternatives during construction, operations, and closure and reclamation. The applicable regulations and policies establish thresholds for evaluating air quality impacts, and this section includes a description of the existing environment and potential consequences (impacts on air quality) of the proposed action and alternatives under that regulatory framework. The regulatory framework protects aesthetic and human health conditions. Beyond regulation of specific contaminants, the Forest Service has further responsibility to consider the impacts of air quality to special areas like wilderness and national parks, and these effects are also considered in this section. We briefly summarize some aspects of the analysis in this section. Additional details not included are captured in the project record (Newell et al. 2018).

3.6.2 Analysis Methodology, Assumptions, and Uncertain and Unknown Information

3.6.2.1 Analysis Area

The full analysis area consists of the area modeled for potential air quality impacts (the "near field" and "far field" areas) and can be seen in figure 3.6.2-1. The physical nature of the emission, along with the location, operating times, and amount of emissions are developed for each emission source. The ambient air quality impacts are assessed at locations (receptors) that begin at the fence line or ambient air boundary of each of the plant sites (East Plant Site, West Plant Site, tailings storage facility, filter plant and loadout facility). The applicable regulations and policies have established thresholds for evaluating air quality impacts and include special provisions for sensitive areas (Class I areas such as national parks and wilderness areas, and certain sensitive Class II areas); these sensitive areas fall within the analysis area as well.

3.6.2.2 Methodology

Air Quality Modeling and Direct Emission Amounts

The assessment of air quality impacts is a complex process that begins with identifying and characterizing the air emission sources and quantifying emission rates from the proposed action, based on the GPO. Air Sciences Inc. (Air Sciences) identified the physical nature of the emissions, along with the location, operating times, and amount of emissions for each emission source. Modeling of

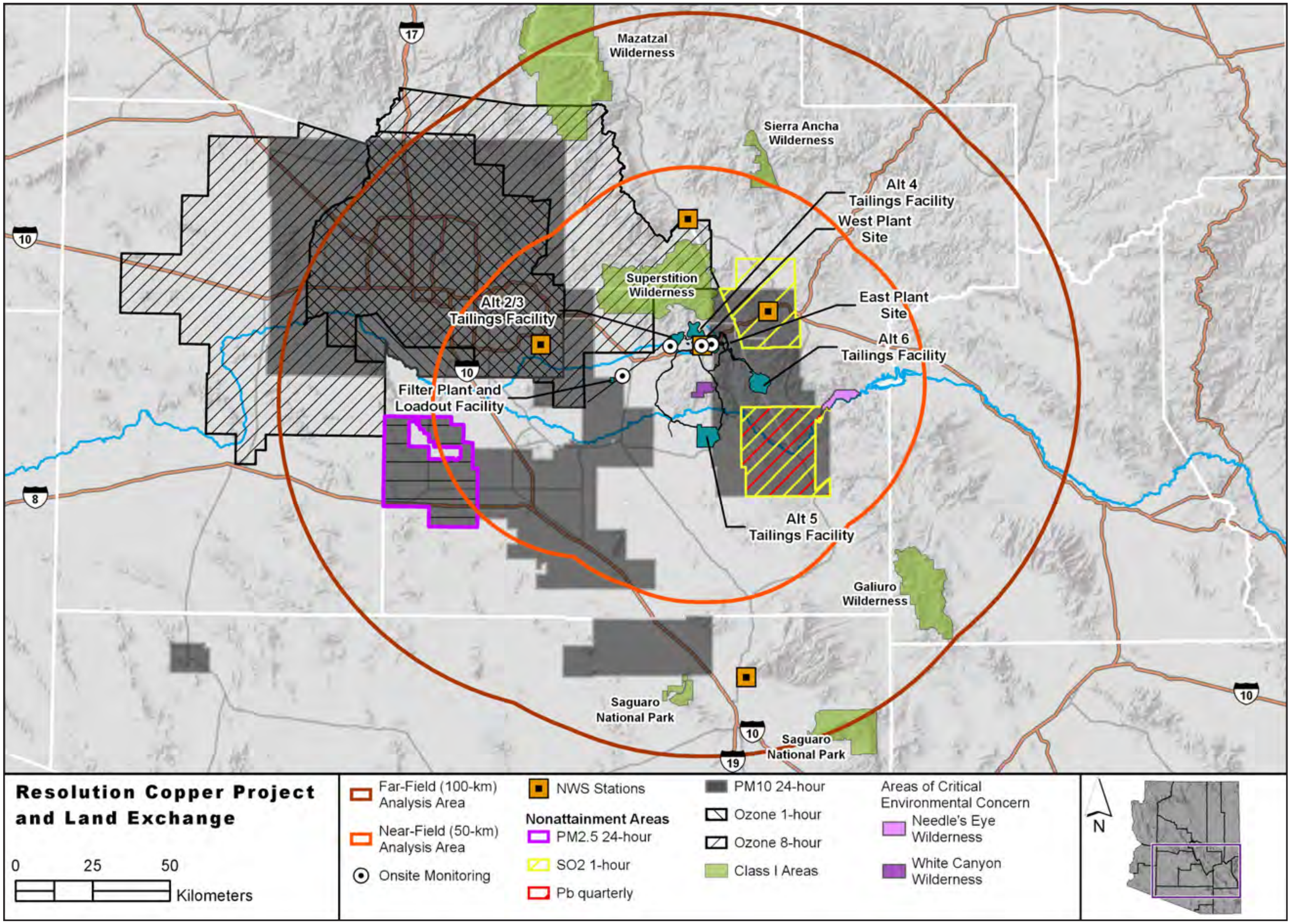


Figure 3.6.2-1. Analysis area showing proposed action and alternatives, sensitive areas, and meteorological monitoring sites

these emissions, combined with background concentrations, is evaluated at the ambient air boundary[26] of each plant site (East Plant Site, West Plant Site, tailings storage facility, filter plant and loadout facility). Those boundaries are shown in figure 3.6.2-1.

Based on guidance from the ADEQ, the EPA, 40 CFR Part 51 Appendix W, and the Forest Service, analysts examined the impacts within 50 km ("near field") of the site locations with one model, and impacts beyond 50 km ("far field") with a different dispersion model (Arizona Department of Environmental Quality 2015; U.S. Forest Service et al. 2010). The EPA approves the AERMOD modeling system to determine impacts in the near field of the source or facility. A separate model platform, CALPUFF, is used to determine far field impacts from 50 km to 100 km from the facility or operation. Each model requires a separate set of meteorological data to capture the atmospheric dispersion characteristics, and each model produces a gridded output of impacts at ground-level receptors. The dispersion models relies on 2 continuous years of meteorological data collected from the on-site monitors. The AERMOD dispersion models used 2 continuous years of meteorological data collected from the on-site monitors, and the CALPUFF model used 3 years of gridded data (2015–2017).

Emissions vary over the life of the mine, with the maximum potential emissions occurring in year 14 (Air Sciences Inc. 2019). At this point in time, process sources would be operating at maximum capacity. Fundamentally, the dispersion modeling platforms require that emission sources be categorized into one of two groups based on the physical characteristics of the emission source. *Point* sources are used to model emissions that are released through a vent, stack, or opening. *Area* sources are used to model fugitive emissions sources such as wind erosion from disturbed surfaces, reentrained dust from roadways, and tailpipe emissions from motor vehicles. Each group involves a different approach to characterizing emissions and estimating impacts at nearby receptors (Air Sciences Inc. 2018b). The total emissions for year 14 are provided in table 3.6.2-1 and include emissions for Alternative 2 (Air Sciences Inc. 2018c).

Table 3.6.2-1. Total annual controlled emissions for proposed action (tons/year)

Source Category	CO	NO_x	$PM_{2.5}$	PM_{10}	SO_2	VOC
Process	20.6	44.4	29.2	49.5	15.0	69.3
Fugitive	28.8	5.5	45.4	276.4	1.8	0.2
Mobile	566.0	68.5	3.2	2.9	1.0	33.2
Total	**615.9**	**118.4**	**77.8**	**328.9**	**17.8**	**102.7**

Notes: Totals may not sum exactly due to rounding.

CO = carbon monoxide; NOx = nitrogen oxides; PM2.5 = particulate matter 2.5 microns in diameter or smaller; PM_{10} = particulate matter 10 microns in diameter or smaller; SO2 = sulfur dioxide; VOC = volatile organic compound

For an overall comparison of the alternatives, the potential emissions that pose the greatest concern, and represent the greatest potential differences from an air quality perspective, include fugitive dust (particulate matter 10 microns in diameter or smaller [PM_{10}] and particulate matter 2.5 microns in diameter or smaller [$PM_{2.5}$]) emissions, process PM_{10} and $PM_{2.5}$ emissions, and emissions of nitrogen oxides (NO_X) from diesel-fired equipment. Total lead emissions would be 0.023 ton/year (46 lb/year), and impacts are not further analyzed (Newell et al. 2018).

In addition to these criteria pollutant[27] emissions, there are small amounts of hazardous air pollutants (HAPs) emitted from the proposed project (Newell et al. 2018). The estimated potential HAP emissions

26. The "ambient air boundary" represents the location where air quality is modeled, including both background air quality and contributions from the project. National Ambient Air Quality Standards (NAAQS) must be met at this boundary. For this project, the fence line at each facility along with an established area of restricted access was used to represent the ambient air boundary. Public access is excluded within this area. Therefore, ensuring that regulatory standards are met at this point is protective of public health.

27. "Criteria pollutants" are regulated by the Clean Air Act, and each criteria pollutant has a numeric NAAQS that must be met. There are six basic criteria pollutants: carbon monoxide (CO), lead (Pb), nitrogen dioxide (NO_2), ozone (O_3), particulate matter (further divided into PM_{10} and $PM_{2.5}$), and sulfur dioxide (SO_2).

from the project are less than the major source thresholds (10 tons/year of any one HAP or 25 tons/year of all HAPs) under the National Emission Standards for Hazardous Air Pollutants (40 CFR 63). Therefore, the project would be classified as an area source and would be subject only to limited Maximum Achievable Control Technology standards for area sources, as listed in that regulation.

To meet regulatory requirements of the Pinal County Air Quality Control District (PCAQCD), Resolution Copper performed dispersion modeling and impact analyses in support of their permit application to construct this facility. The proposed action qualifies as a "minor source" for PCAQCD permitting purposes. This assessment uses the dispersion modeling analysis to demonstrate compliance with applicable PCAQCD and NAAQS within 50 km of the project area. Details of the AERMOD permitting analysis, input, receptor grids, settings, and results are provided in Air Sciences (2018c). The Forest Service is using the same model to understand and disclose impacts in the EIS.[28] In addition to the ambient air boundary and surrounding nested receptor grid, impacts are also specifically assessed at identified Sensitive Areas and Class I areas (the Superstition Wilderness Area),[29] which are depicted in figure 3.6.2-1.

Within the 50-km distance from the proposed action sites, the analysis also addresses impacts on air quality, acid deposition, and plume blight. Sensitive areas within this range include the Superstition Wilderness, the White Canyon Area of Critical Environmental Concern (ACEC), and the Needle's Eye Wilderness.

Impacts on regional haze and acidic deposition at Class I areas beyond 50 km and within 100 km of the project are evaluated using the CALPUFF dispersion model system, approved for use by the EPA. Details of the CALPUFF modeling are provided in Air Sciences (2018c). The Class I areas that Air Sciences evaluated include Galiuro Wilderness, Mazatzal Wilderness, Saguaro National Park and Saguaro Wilderness Area, and the Sierra Ancha Wilderness. The analysis of these areas includes air quality impacts, compared with ambient standards and prevention of significant deterioration (PSD) increments, visibility or haze, and deposition of total sulfur and nitrogen.

Generally, air quality impacts from a source decrease with distance from that source. As a first step, areas are screened from analysis using the standard source/distance (U.S. Forest Service et al. 2010) method based on the total emissions of PM_{10}, sulfur dioxide (SO_2), NO_X, and sulfuric acid (H_2SO_4) in tons per year divided by the distance to the area in kilometers. Using this method, Air Sciences screened several areas as too distant: the Pine Mountain Wilderness, Mount Baldy Wilderness, and Sycamore Canyon Wilderness (Air Sciences Inc. 2018c).

Impacts on visibility and deposition are compared with the established acceptable levels of impact at receptors in each Class I area, using both the 24-hour maximum and the annual emission rates to assess visibility and deposition, respectively. Maximum impacts for each Class I and sensitive Class II area are tabulated for each parameter.

Climate Change and Greenhouse Gas Emissions

While global surface air temperatures have increased over the past century, changes in the Southwest have caused markedly increased average annual temperatures and reduced water storage due to early spring snowpack runoff (Garfin et al. 2013; Intergovernmental Panel on Climate Change 2013). It is extremely likely that anthropogenic factors have caused most of the increase in global surface temperatures and emissions of greenhouse gases (Romero-Lankao et al. 2014), which

28. Note that while the same air quality model may be used, the specific output may differ between PCAQCD permitting requirements and Forest Service NEPA requirements. The results shown in the DEIS reflect the total emissions from the project, regardless of whether they are applicable to the PCAQCD permit process.

29. "Class I" areas are defined by the Clean Air Act and receive special consideration for air quality impacts. A Class I area must be specifically designated by the EPA; these usually include national parks, wilderness areas, monuments, and other areas of special national and cultural significance. Most of the rest of the country is considered a "Class II" area. However, in some cases, sensitive Class II areas (such as the White Canyon ACEC) are treated similarly to Class I areas.

include carbon dioxide (CO_2), nitrous oxide, and methane, among others. The trends in temperature and effects of snowmelt runoff, with declining river flow, are predicted to continue into the foreseeable future (Garfin et al. 2013).

The proposed action would lead to emissions of greenhouse gases based largely on fuel use by mobile sources with a minor contribution from process combustion sources. The total greenhouse gas emissions would amount to 173,328 CO_2 equivalent tonnes/year, based on year 14 with the highest emission rates. Project emissions would contribute to ongoing climatic trends.

Indirect Emission Amounts

Modeling for compliance with air quality standards is based on direct emissions from point and area sources for the various components of the project. Additional emissions can be indirectly caused by the project by the expected increase in road traffic for employee travel or deliveries and are estimated in table 3.6.2-2 (Newell et al. 2018).

Table 3.6.2-2. Total annual indirect emissions for proposed action caused by employee traffic and deliveries (tons/year)

Source Category	CO	NO_x	$PM_{2.5}$	PM_{10}	SO_2	VOC
Employees	64.4	3.0	5.5	22.6	0.2	0.7
Deliveries	1.3	3.7	4.7	19.4	0	0.3
Total	**65.7**	**6.6**	**10.1**	**42.0**	**0.2**	**1.0**

Notes: Totals may not sum exactly due to rounding.

CO = carbon monoxide; NO_x = nitrogen oxides; $PM_{2.5}$ = particulate matter 2.5 microns in diameter or smaller; PM_{10} = particulate matter 10 microns in diameter or smaller; SO_2 = sulfur dioxide; VOC = volatile organic compound

Health Risk Assessment

For the purposes of the NEPA analysis, the ability to meet air quality standards is considered protective of public health;[30] therefore, a separate health-based analysis of individual constituents, particularly those associated with particulate emissions, is not necessary in order to disclose impacts on human health (SWCA Environmental Consultants 2018b). However, the levels of metals deposition associated with particulate emissions were estimated and compared with Regional Screening Levels for which the EPA has derived carcinogenic and/or non-carcinogenic chronic health effects. Where the cancer risk health quotient is less than 1, excess cancer risk is less than 1×10^{-6}, and where the non-carcinogenic chronic health effects health quotient is less than 1, the health index for non-carcinogenic chronic health effects is less than 1. For all alternatives, the estimated human health risk associated with the maximum air concentrations of inorganic metals is less than 1×10^{-6} cancer risk (representing a risk below 1.0 for cancer) and below 1.0 for non-carcinogenic chronic health effects. Further background about these estimations can be found in Newell et al. (2018).

Presence of Asbestiform Minerals or Naturally Occurring Radioactive Materials

An analysis was conducted to identify the presence of asbestiform minerals that could become part of the tailings, as well as naturally occurring radioactive materials. A summary of these investigations is contained in Section 3.7.2. Groundwater and Surface Water Quality. The

30. The NAAQS are promulgated to protect human health with an adequate margin of safety (see Clean Air Act 109(b) and 40 CFR 50.2).

investigation determined that substantial information exists to answer these questions, and neither asbestos nor radioactive materials are present in the ore body above typical background concentrations.

3.6.3 Affected Environment

3.6.3.1 Relevant Laws, Regulations, Policies, and Plans

A wide range of Federal, State, and local requirements regulate air quality impacts of mine operations. Many of these require permits before the mine operations begin; others may require approvals or consultations, mandate the submission of various reports, and/or establish specific prohibitions or performance-based standards (Newell et al. 2018; U.S. Forest Service et al. 2010).

Primary Legal Authorities Relevant to the Air Quality Effects Analysis

- Pinal County has been delegated responsibility under the Clean Air Act, and County, State, and Federal air quality regulations would be met through issuance of a Class II air permit (West Pinal PM_{10} Moderate Nonattainment Area, Chapter 4 Article 1 of the PCAQCD Code of Regulations)
- Additional Forest Service guidance for air-quality related values (deposition and visibility) contained in U.S. Forest Service et al. (2010)
- General Conformity Rule (Clean Air Act Section 176(c)(4); implanted in 40 CFR 93); applicable only to Alternatives 5 and 6

3.6.3.2 Existing Conditions and Ongoing Trends

Resolution Copper conducted air quality and meteorological monitoring at the proposed project area. The locations of the monitors are shown in figure 3.6.2-1. Particulate matter (PM_{10} and $PM_{2.5}$) has been monitored at the West Plant monitoring site and the East Plant monitoring site. Nitrogen dioxide (NO_2), SO_2, and ozone have been monitored at the East Plant Site. The results of the Resolution Copper air quality monitoring program are shown in figure 3.6.3-1, along with the applicable ambient standards. The data show some year-to-year variability, but there is no evident trend, except for the 1-hour SO_2 levels.

All monitoring data show compliance with the applicable standards, except potentially for ozone (the 3-year average, eighth highest daily maximum ozone level, is used to evaluate compliance with the standard). The arithmetic average of the last 3 years of ozone monitoring is 0.072 parts per million (ppm) (truncated), which is above the current ambient standard of 0.070 ppm. The data show the variability over the 5-year period and include relatively high PM_{10} and $PM_{2.5}$ levels in 2013. Although there is no distinct trend except for the annual $PM_{2.5}$ at the West Plant Site, the West Plant Site shows an annual average increase of 0.4 micrograms per cubic meter (µg/m^3) per year in $PM_{2.5}$ concentrations over the monitoring period. The hourly NO_2 and SO_2 levels have steadily declined over this period, until 2017.

Resolution Copper collected meteorological data at three sites near the proposed mine operations, including the East Plant Site, West Plant Site, and Near West location, and used data from 2 years (2015–2016) to conduct the near-field air quality impact analysis. The data include wind speed, wind direction, stability category, and temperature. The data show a strong prevailing wind pattern at all sites with the dominant prevailing wind from the northeast quadrant for the East Plant Site and West Plant Site, and from the southeast quadrant for the Near West location. A secondary prevailing wind from the west and southwest is evident at all sites.

Conformity

The General Conformity Rule was established under Clean Air Act Section 176(c)(4) and implemented in 40 CFR 93; it serves to ensure

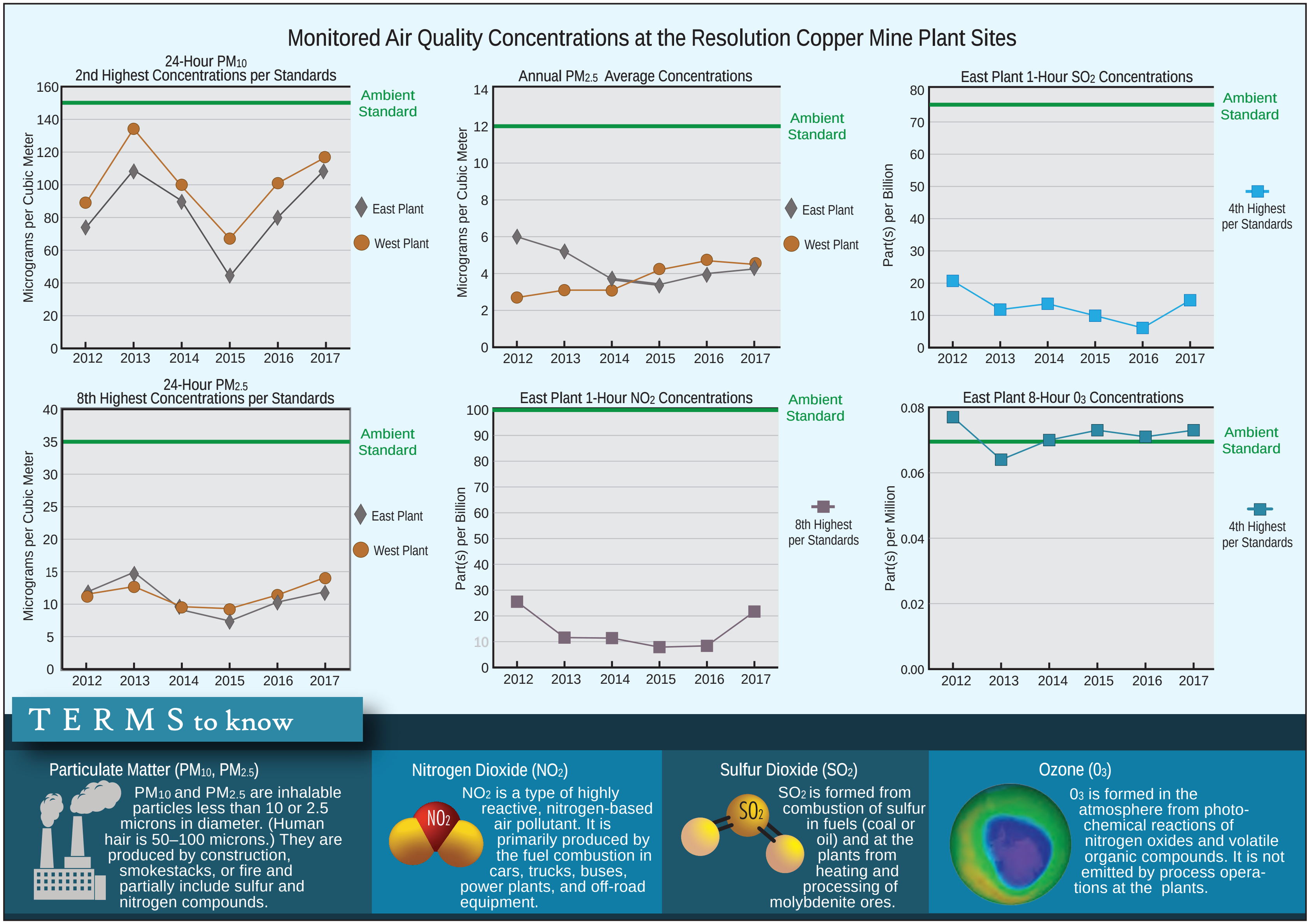


Figure 3.6.3-1. Monitoring results for PM_{10}, $PM_{2.5}$, NO_2, SO_2, and ozone relative to standards under 40 CFR 50

that Federal actions do not inhibit State attainment plans for areas designated as non-attainment or maintenance. The rule effectively applies to all Federal actions that take place in areas designated as non-attainment or maintenance. The near-field project analysis area is located within three counties (Pinal, Maricopa, and Gila Counties, Arizona). The East Plant Site would be partially located in the Hayden PM_{10} Nonattainment Area and the filter plant and loadout facility would be located in the West Pinal PM_{10} Nonattainment Area.

The Forest Service has determined that a conformity analysis for this area is not warranted for the alternatives in or near these two Nonattainment Areas (Newell et al. 2018). At the time of publication of the DEIS, the ADEQ is petitioning the EPA to have the Hayden PM_{10} area designated as Attainment, based on the fact that ambient concentrations have not exceeded the standards for several years (Arizona Department of Environmental Quality 2018b). In addition, modeling results (Air Sciences Inc. 2018c) demonstrate that the impacts from the proposed alternatives do not exceed the ambient air quality standards. The filter plant and loadout facility would be located within the West Pinal PM_{10} Nonattainment Area, but a formal General Conformity analysis would not be required for this Nonattainment Area, for reasons including that PM_{10} emissions are well below the 100 tons/year threshold, and dispersion modeling demonstrates that PM_{10} impacts around this facility are well below the applicable standard.

Regional Climatology

The regional climate is characterized as semiarid; there are often long periods with little or no precipitation (Western Regional Climate Center 2018). Precipitation falls in a bimodal pattern: most of the annual rainfall within the region occurs during the winter and summer months, with dry periods mainly in the spring and fall. The total average annual precipitation varies between 15.7 inches and 18.8 inches, with 52 percent of the precipitation falling between November and April. Although there may be snow at higher elevations, it does not typically accumulate in the region. Precipitation usually occurs with steady, longer duration frontal storm events during the winter months (December through March). Rain events during the summer months (July to early September) are typically of shorter duration with more intensity associated with thunderstorms.

3.6.4 Environmental Consequences of Implementation of the Proposed Mine Plan and Alternatives

3.6.4.1 Alternative 1 – No Action

Under the no action alternative, there would be no impacts on air quality from proposed mining and associated activities. Existing and ongoing impacts on air quality from fugitive dust and vehicle emissions are expected to increase over time with continued population growth in central Arizona. However, it is expected that monitoring and remedial actions by Maricopa County, Pinal County, and ADEQ would be effective in keeping these gradual changes within NAAQS.

3.6.4.2 Direct and Indirect Effects Common to All Action Alternatives

Effects of the Land Exchange

The land exchange would have limited effects on air quality. The Oak Flat Federal Parcel would leave Forest Service jurisdiction; no significant effects are expected. However, the Tonto National Forest would lose its authority to provide direction and support to management activities in order to meet minimum air standards.

The offered lands parcels would enter either Forest Service or BLM jurisdiction, allowing those agencies to secure authority over management activities pertaining to air quality. However, it is important to note that the air quality currently existing within the offered lands parcels is unlikely to experience significant change after transfer to Federal jurisdiction. These parcels are primarily inholdings of surrounding Forest Service– or BLM-managed lands and likely reflect air quality of the surrounding areas that are already managed to achieve these air quality standards.

Effects of Forest Plan Amendment

The Tonto National Forest Land and Resource Management Plan (1985b) provides guidance for management of lands and activities within the Tonto National Forest. It accomplishes this by establishing a mission, goals, objectives, and standards and guidelines. Missions, goals, and objectives are applicable on a forest-wide basis. Standards and guidelines are either applicable on a forest-wide basis or by specific management area.

A review of all components of the 1985 forest plan was conducted to identify the need for amendment due to the effects of the project, including both the land exchange and the proposed mine plan (Shin 2019). One standard and guideline was identified applicable to air quality. This standard and guideline was found to not require amendment to the proposed project, either on a forest-wide or management area–specific basis. For additional details on specific rationale, see Shin (2019).

Summary of Applicant-Committed Environmental Protection Measures

A number of environmental protection measures are incorporated into the design of the project that would act to reduce potential impacts on air quality. These are non-discretionary measures, and their effects are accounted for in the analysis of environmental consequences.

From the GPO (Resolution Copper 2016d), Resolution Copper has committed to a variety of measures to reduce potential impacts on air quality:

- Dust control on roads, including regular watering, road base maintenance and dust suppression, paving select access roads to the East Plant Site and West Plant Site with asphalt, and setting reasonable speed limits on access roads within the operational footprint.
- Dust control at the tailings storage facility, including delivering tailings to the storage facility via distribution pipelines and continuously wetting the tailings during active deposition. During non-active periods, dust emissions would be managed by establishing a temporary vegetative cover on construction areas that would be inactive and exposed for longer than 12 months, wetting inactive beaches and embankment surfaces with irrigation from sprinkler systems, and treatment with chemical or polymer dust suppressants, if necessary.
- Dust control at East Plant Site, including periodic water and/or chemical dust suppressant, normal mining controls such as wet drilling and the wetting of broken rock, application of water suppression spray to control dust ore conveyance, dedicated exhaust ventilation systems and/or enclosures for crushers and transfer points underground, performing primary crushing and conveying underground, and saturating underground exhaust ventilation.
- Dust control at West Plant Site, including housing main active ore stockpiles in fully covered buildings, applying water suppression spray to control dust ore conveyance, processing ore in a new enclosed building, and enclosing conveyor transfer points within the concentrator building.
- Dust control during shipping, including bagging molybdenum concentrate at the concentrator facility before shipping and enclosing loadout building and storage shed.

Other applicant-committed environmental protection measures by Resolution Copper include those outlined in the "Final Air Quality Impacts Analysis Modeling Plan" (Air Sciences Inc. 2018a) and Resolution Copper's current air quality permit, including the following:

- Use of low-sulfur diesel in mobile and stationary equipment;
- Use of a scrubber to control SO_2 emissions from the drying of molybdenum concentrate at the West Plant Site;
- Use of Tier 4 diesel engines (or greater); and

- Use of fencing, berms, locking gates, signage, natural barriers/ steep terrain (25 to 30 percent or greater), and site security measures to limit access roads and other locations near areas of heavy recreational use. These same methods would be required to limit public access within the mine site (i.e., the air modeling boundary) to prevent public exposure to mine emissions.

Air Quality Impact Assessment

The dispersion modeling effort described in section 3.6.3 is used to characterize ambient air quality impacts at receptors in the area of each of the proposed facilities (East Plant Site, West Plant Site, filter plant, and loadout facility), as well as the alternative tailings storage facility locations. Air Sciences generated a composite receptor grid of the impacts from the separate model runs for these facilities and used the grid to evaluate impacts; in other words, the emissions from each facility were modeled separately but then combined to assess impacts. The maximum impact for each of the criteria air pollutants over the composite receptor grid determines the direct effects of the proposed action and the alternatives. The impacts include the model results of emissions from the proposed action and alternatives added to a "background" air quality value that represents the ongoing impacts from other sources (including natural sources) in the area, and in effect represents the cumulative impact of the proposed action and other sources (Air Sciences Inc. 2018b). The background concentrations are based in part on the Resolution Copper data from the monitoring sites (see figure 3.6.3-1). These impacts are then compared with the appropriate standard, some of which have specific time components (i.e., 8-hour average). Details of the analysis are provided in Air Sciences (2018c).

Results of the modeled maximum impacts at all receptors for each of the criteria air pollutants are shown in table 3.6.4-1 for the proposed action (Alternative 2 – Near West Proposed Action). The emissions from the mining and processing operations at the East Plant Site, West Plant Site, and tailings storage facility boundary are taken from the year of maximum ore production (year 14) and added to the impacts from the maximum erodible area for the affected tailings storage facility.[31] Annual impacts are based on the annual average emission rate for each source; maximum hourly impacts are based on the hourly maximum emission rate for all sources; and 24-hour maximum impacts are based on the maximum 24-hour emission rate for the sources. None of the predicted results are anticipated to exceed the NAAQS at the ambient air boundary/fence line.

Air quality impacts were modeled for each alternative, but the results are largely the same. Maximum impacts for other alternatives would be very similar to those shown in table 3.6.4-1. Detail of the results of other alternative air quality modeling are contained in Newell et al. (2018).

For all alternatives, the maximum total impacts for carbon monoxide (CO), 1-hour NO_2, and short-term SO_2 (24 hours or less) would occur at or near the boundary of the East Plant Site due to the large number of combustion sources at that site. The maximum annual impacts for NO_2 would occur at the filter plant and loadout facility and the maximum annual SO_2 impacts would occur at the West Plant Site, although both impacts would be well below the applicable ambient air quality standards.

As can be noted from table 3.6.4-1, maximum 1-hour NO_2 impacts would be about 78 percent of the standard, based on the average of the daily maximum 1-hour 98th percentile value over a 2-year period. Figure 3.6.4-1 shows the maximum impact for the 1-hour NO_2 design value at receptors around the East Plant Site and West Plant Site for

31. For the tailings facilities, the largest source of contaminants is fugitive dust, which largely depends on the amount of ground disturbed and exposed to wind. Therefore, assuming the largest exposed area—even at years before buildout occurs—ensures that air quality impacts are not underestimated.

Table 3.6.4-1. Maximum air quality impacts for proposed operations and Alternative 2 – Near West Proposed Action

Pollutant	Model Result/Form of Standard	Proposed Action Impact Only (µg/m³)	Background (µg/m³)	Total Maximum Impact (µg/m³)	Standard (µg/m³)	Total Maximum Impact as a Percentage of Standard
CO_1H	3rd high over 2 years	4,531	3,550	8,081	40,500	20
CO_8H	3rd high over 2 years	1,040	2,519	3,559	10,000	36
NO_2_1H	98th percentile over 2 years	138	9	146	188	78
NO_2_AN	Max annual over 2 years	2	3	5	100	5
PM_{10}_24H	3rd high over 2 years	26	71	97	150	65
PM_{10}_AN*	Max annual over 2 years	7	17	25	50	49
PM_{25}_24H	98th percentile over 2 years	11	6	18	35	51
PM_{25}_AN	Average annual over 2 years	2	4	6	12	49
SO_2_1H	99th percentile over 2 years	92	24	117	196	59
SO_2_3H	2nd high over 2 years	56	31	86	1,300	7
SO_2_24H*	2nd high over 2 years	9	11	20	365	6
SO_2_AN*	Max annual over 2 years	1	2	3	80	4

Note: µg/m³ = micrograms per cubic meter
* Not a Federal standard

Alternative 2 – Near West Proposed Action.[32] The overall maximum would occur at the ambient air boundary of the East Plant Site, with the relatively higher values toward the north and east of the East Plant Site. Predicted impacts are reduced substantially with distance from the East Plant Site ambient air boundary. The impacts are analyzed and depicted on a nested grid of receptors (see figure 3.6.4-1).

The maximum design value 24-hour average impacts for $PM_{2.5}$ would occur at the eastern boundary of the East Plant Site, as shown in figure 3.6.4-2 (also for Alternative 2 – Near West Proposed Action). The maximum 24-hour average impacts, as well as the annual average impacts for $PM_{2.5}$ and PM_{10}, occur at or near the boundaries of the East Plant Site, West Plant Site, and tailings storage facility. The predicted highest impacts tend to be captured within the 100-m grid spacing, within 1 km of the ambient air boundary. Impacts at most of the receptors around the East Plant Site and other project sites would be less than one-half of the design value ambient standard.[33] Maximum $PM_{2.5}$

32. In figures 3.6.4-1 and 3.6.4-2, the impacts are analyzed and depicted on a nested grid, with a sub-grid of receptors at 100-m spacing out to 1 km from the ambient air boundary, a 500-m grid spacing from 1 km to 5 km from the boundary, nested 1,000-km and 2,500-km grid spacing beyond that distance, and 25-m receptors along the ambient air boundaries and nearby roadways. The more densely nested 100-m sub-grid is clearly depicted in the figure, and the higher impacts are captured largely within this sub-grid of receptors.

33. The design value of the ambient air quality standard refers to the calculation of compliance with the standard. For example, the design value of the 1-hour NO_2 standard is the 3-year average of the annual 98th percentile of the highest daily 1-hour ozone concentration.

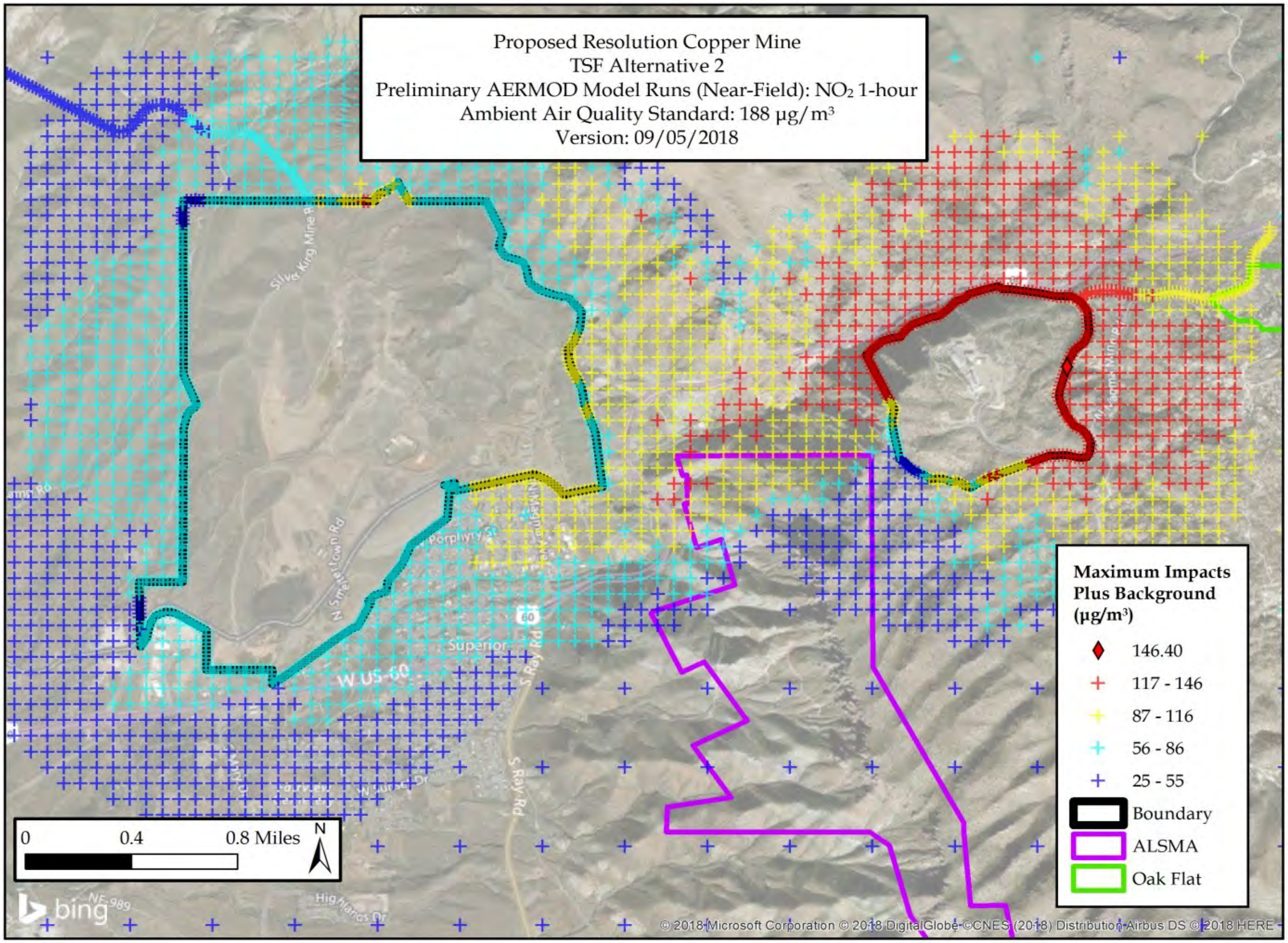


Figure 3.6.4-1. Maximum 1-hour 98th percentile NO_2 impacts at receptors near East Plant Site and West Plant Site for Alternative 2 – Near West Proposed Action

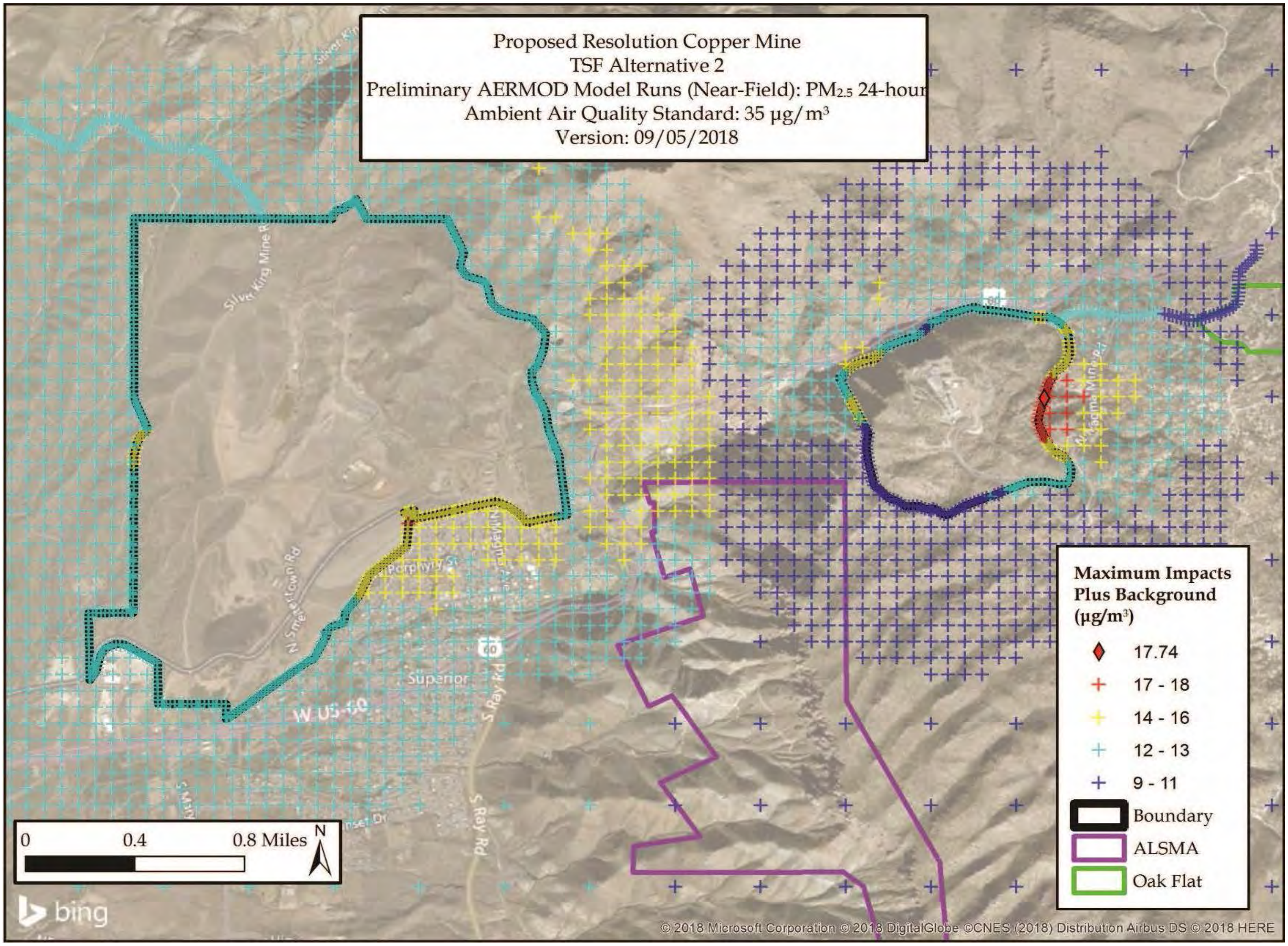


Figure 3.6.4-2. Maximum 24-hour 98th percentile $PM_{2.5}$ impacts at receptors near the tailings storage facility for Alternative 2 – Near West Proposed Action

impacts for the other alternatives are equivalent to Alternative 2, and are also located around the East Plant Site boundary.

A separate analysis of ozone formation and secondary $PM_{2.5}$ formation was conducted (Air Sciences Inc. 2018c) based on total emissions using the thresholds provided by the EPA (2017). Results indicate that the maximum impacts would be below the established thresholds of impact for both of these pollutants, as provided by the guidance. The calculated secondary $PM_{2.5}$ would be 0.23 $\mu g/m^3$ for the 24-hour maximum impact and 0.008 $\mu g/m^3$ for the maximum annual impact. Adding these results to the calculations for primary $PM_{2.5}$ impacts would not change the data that are provided in table 3.6.4-1.

Impacts at Sensitive Areas

As designated during the scoping process, the Forest Service identified specific sensitive areas that include Class I areas and Areas of Critical Environmental Concern (ACECs). Areas within 50 km of the proposed action are modeled using the AERMOD platform, and areas from 50 to 100 km are analyzed using the CALPUFF modeling platform. These models use different characterizations to conduct the analyses (see Air Sciences (2018c)).

Table 3.6.4-2 provides the projected maximum incremental air quality impact for any of the alternatives at all receptors in each designated area. Representative background concentrations were not added to the modeled impacts. The analysis focuses on determining whether impacts at the Class I areas and sensitive Class II areas are of concern, and since the air quality impacts are below established significance levels, additional analysis with background concentrations is not warranted. Among the alternatives, and all the Class I areas, the impacts from Alternative 4 are greatest at the Superstition Wilderness, but they remain well below the PSD increments. Impacts represent the maximum among the alternatives; impacts for the other alternatives are less than the reported value and may be below 50 percent of that impact.

All impacts are projected to be less than the PSD increments at the Class I areas and, except for the Superstition Wilderness, would have an insignificant[34] impact at those areas. The highest 24-hour impacts of PM_{10} and $PM_{2.5}$ emissions on air quality at the Superstition Wilderness consume up to 50 percent of the Class I PSD increments for those standards but are well below ambient standards, when background concentrations are added. Impacts are greatest at the area boundary and decrease rapidly with distance toward the remainder of the area. All ambient air quality impacts at the (Class II) White Canyon ACEC are well below the Class II PSD increments. The maximum impacts at this area are for $PM_{2.5}$; PM_{10} is 8 percent of the PSD Class II increments.

Impacts on the deposition of nitrogen (N) and sulfur (S) from the proposed action have also been projected through the same modeling platforms. Impacts are compared with the designated Deposition Analysis Thresholds (DAT) (U.S. Forest Service et al. 2011). The DAT value for S is 5 grams/hectare/year (g/ha/year) and for N is 10 g/ha/year. Results for the maximum deposition at each area among all the alternatives are provided in table 3.6.4-3, for both the S and N deposition estimates for the proposed action. There is little difference among the impacts of the alternatives at each of the sensitive areas.

Visibility impacts are analyzed separately depending on the distance from the source of emissions. Within 50 km, impacts on plume blight[35] at the Superstition Wilderness and the White Canyon ACEC are based on designated vistas within those areas. The impacts are generated under the PLUVUE II analysis (U.S. Environmental Protection Agency 1992), which focuses on a single plume and is analyzed only for meteorological conditions during daylight hours. The analysis is directionally dependent, and where appropriate a representative characterization of the 24-hour emissions of SO_2, NO_X, and PM_{10} were combined into a single

34. Comparisons with the PSD Class I Significant Impact Levels are provided for information only. No formal further analysis is required because the proposed action and alternatives do not trigger review and approval under the PSD regulations.

35. Plume blight is a visual impairment of air quality that manifests itself as a coherent plume.

Table 3.6.4-2. Maximum ambient air quality impacts at identified sensitive areas

	Class I Areas							Class II Areas	
Pollutant / Standard*	**PSD Class I Increment ($\mu g/m^3$)**	**Superstition Wilderness ($\mu g/m^3$)**	**Sierra Ancha Wilderness ($\mu g/m^3$)**	**Mazatzal Wilderness ($\mu g/m^3$)**	**Galiuro Wilderness ($\mu g/m^3$)**	**Saguaro National Park ($\mu g/m^3$)**	**PSD Class II Increment ($\mu g/m^3$)**	**White Canyon ACEC† ($\mu g/m^3$)**	**Needle's Eye Wilderness† ($\mu g/m^3$)**
NO_2_AN	**2.5**	0.109	0.007	0.008	0.009	0.010	**25**	0.60	0.011
PM_{10}_24H	**8.0**	4.26	0.463	0.394	0.476	0.793	**30**	2.46	0.454
PM_{10}_AN	**4.0**	0.318	0.018	0.020	0.027	0.028	**17**	0.168	0.030
$PM_{2.5}$_24H	**2.0**	1.57	0.123	0.125	0.139	0.173	**9**	0.834	0.146
$PM_{2.5}$_AN	**1.0**	0.119	0.006	0.009	0.007	0.008	**4**	0.053	0.010
SO_2_3H	**25**	4.41	0.380	0.294	0.251	0.340	**512**	2.55	0.334
SO_2_24H	**5**	0.994	0.080	0.076	0.053	0.054	**91**	0.478	0.066
SO_2_AN	**2**	0.008	0.002	0.001	0.003	0.002	**20**	0.023	0.003

Notes: $\mu g/m^3$ = micrograms per cubic meter; shaded columns show standard for comparison for the Class I and Class II areas evaluated in this table
* See table 3.6.4-1 for more detail on specific standards
† PSD Class II Increments apply to White Canyon ACEC and Needle's Eye Wilderness

Table 3.6.4-3. Maximum deposition analysis impacts at sensitive areas

Constituent	DAT Value (g/ha/year)	Superstition Wilderness (g/ha/year)	White Canyon ACEC (g/ha/year)	Sierra Ancha Wilderness (g/ha/year)	Mazatzal Wilderness (g/ha/year)	Galiuro Wilderness (g/ha/year)	Saguaro National Park (g/ha/year)	Needle's Eye Wilderness (g/ha/year)
Sulfur	5	1.42	0.77	0.16	0.10	0.05	0.02	0.22
Nitrogen	10	4.18	2.94	0.33	0.19	0.15	0.05	1.06

Note: g/ha/year = grams per hectare per year

plume. Results are provided for each of the observer locations in the two areas in table 3.6.4-4, indicating the number of daylight hours per year that a plume is perceptible at the indicated vistas for Alternatives 2 and 3. Perceptibility is based on the absolute contrast threshold, |C|, of 0.02 and a color contrast for gray terrain, ΔE, of 1.0 (figure 3.6.4-3).

Over the extended areas, the visibility of a plume against terrain features is affected by the height of the terrain and the position of the observer. The frequencies reported represent a general characterization of plume impacts when viewing terrain; there would be generally a 2 to 6 percent probability of a visible plume during daylight hours in the Superstition Wilderness. The impact at any one location could be different based on the terrain and the distance of the plume from the source(s). The plume may be visible in one direction but not in the opposite direction, for example. The frequency of a visible plume impact against the blue sky, however, would generally decrease with farther distances from the source(s). The effect or frequency of cloudy conditions is not taken into account in this analysis.

Beyond 50 km, visibility impacts are predicted based on regional haze, which is a general condition in the impact area based on maximum concentrations of the impacts at those areas. Data for SO_2, NO_X, sulfates, and nitrates are used to evaluate these impacts. Annual average natural conditions are added to the predicted impacts that would occur from the proposed action. Results are shown in table 3.6.4-5 for the highest 98th percentile of the daily percent of extinction among the alternatives. A threshold value of 5 percent from a single source is considered a significance threshold for conducting an additional impact analysis, and a 10 percent cumulative impact is considered a perceptible impact. All impacts are well below the 5 percent threshold that requires further analysis, demonstrating that impacts on regional haze at these locations would not be perceptible for any of the alternatives.

The analysis of air quality impacts for the proposed action and alternatives shows that all impacts would be within the ambient air quality standards and well below the PSD increments. The proposed emission sources would comply with applicable regulations, and impacts

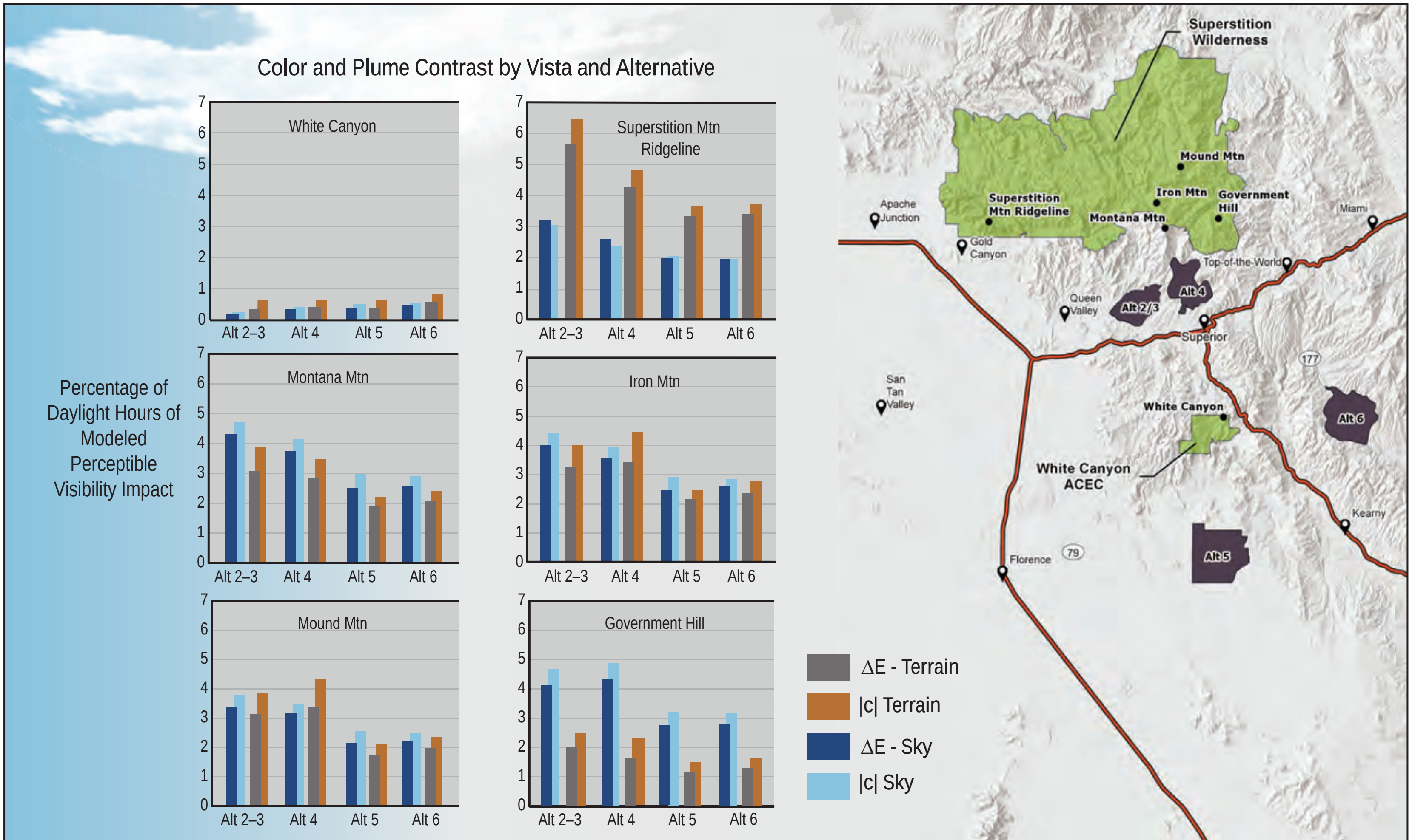
Table 3.6.4-4. Annual total and percentage of daylight hours of perceptible plume blight at observer locations in sensitive areas, Superstition Wilderness, and White Canyon ACEC

Observer Location	|C| Sky	ΔE Sky	|C| Terrain	ΔE Terrain
Montana Mountain (Superstition Wilderness)	206 (4.7%)	189 (4.3%)	170 (3.9%)	136 (3.1%)
Government Hill (Superstition Wilderness)	204 (4.7%)	182 (4.1%)	110 (2.5%)	89 (2.0%)
Iron Mountain (Superstition Wilderness)	194 (4.4%)	177 (4.0%)	177 (4.0%)	143 (3.3%)
Mound Mountain (Superstition Wilderness)	166 (3.8%)	147 (3.4%)	169 (3.8%)	138 (3.1%)
Superstition Mountain ridgeline (Superstition Wilderness)	133 (3.0%)	141 (3.2%)	283 (6.4%)	248 (5.6%)
White Canyon (White Canyon ACEC)	11 (0.2%)	9 (0.2%)	28 (0.6%)	14 (0.3%)

Note: There is a total of 4,386 hours of daylight per year.

Table 3.6.4-5. Impacts of 98th percentile daily regional haze extinction levels in Class I areas

Affected Area	Proposed Action (%)
Threshold	**5**
Sierra Ancha Wilderness	0.35
Mazatzal Wilderness	0.15
Galiuro Wilderness	0.16
Saguaro National Park	0.17



TERMS to know

Color Contrast Parameter (ΔE)

Probably best single indicator of the perceptibility of a plume both to its contrast and its color with respect to a viewing background. Calculated for the entire visible spectrum and indicates how different the brightness and color of plume and background are.

Plume Contrast (|c|)

Relative brightness of a plume compared to a viewing background. Positive contrast indicates a relatively bright plume; negative contrast indicates a dark plume.

Figure 3.6.4-3. Near-field visibility of plume blight based on the absolute contrast threshold, |C|, of 0.02 and a color contrast for gray terrain, ΔE, of 1.0

on air quality-related values would be within the established thresholds for levels of acceptability.

3.6.4.3 Cumulative Effects

The Tonto National Forest identified the following reasonably foreseeable future actions as likely, in conjunction with development of the Resolution Copper Mine, to contribute to cumulative impacts on air quality in the "near field" vicinity of the proposed Resolution Copper Mine and its project alternative component locations (e.g., tailings facilities) as well as at more distant, or "far field," locations in much of Pinal County, Gila County, and Maricopa County (see figure 3.6.2-1). As noted in section 3.1, past and present actions are assessed as part of the affected environment; this section analyzes the effects of any RFFAs, to be considered cumulatively along with the affected environment and Resolution Copper Project effects.

- *Pinto Valley Mine Expansion.* The Pinto Valley Mine is an existing open-pit copper and molybdenum mine located approximately 8 miles west of Miami, Arizona, in Gila County. Pinto Valley Mining Corporation is proposing to expand mining activities onto an estimated 1,011 acres of new disturbance (245 acres on Tonto National Forest land and 766 acres on private land owned by Pinto Valley Mining Corporation) and extend the life of the mine to 2039. This proposed expansion would foreseeably result in construction-related vehicle exhaust emissions (including NO_2, SO_2, and diesel-generated particulate matter) as well as potential increases in airborne particulate matter through large-scale earthmoving, wind effects on newly disturbed and exposed ground, and other activities. However, no data are available at this time to determine how these potential future increases may cumulatively affect overall air quality in the analysis area.
- *Ripsey Wash Tailings Project.* Mining company ASARCO is planning to construct a new tailings storage facility to support its Ray Mine operations. The environmental effects of the project were analyzed in an EIS conducted by the USACE and approved in a ROD issued in December 2018. As approved, the proposed tailings storage facility project would occupy an estimated 2,574 acres and be situated in the Ripsey Wash watershed just south of the Gila River approximately 5 miles west-northwest of Kearny, Arizona, and would contain up to approximately 750 million tons of material (tailings and embankment material). ASARCO estimates a construction period of 3 years and approximately 50 years of expansion of the footprint of the tailings storage facility as slurry tailings are added to the facility, followed by a 7- to 10-year period for reclamation and final closure. An air quality analysis conducted for the EIS found the project to be in conformance with the Clean Air Act (i.e., with no exceedances of criteria pollutant thresholds) and also with the relevant State Implementation Plan. The Ripsey Wash tailings storage facility is intended to replace the existing Ray Mine Elder Gulch tailings storage facility, which would be phased out and closed as the Ripsey Wash facility becomes operational; any additive cumulative effects are thus considered negligible.
- *Ray Land Exchange and Proposed Plan Amendment.* ASARCO is also seeking to complete a land exchange with the BLM by which the mining company would gain title to approximately 10,976 acres of public lands and federally owned mineral estate located near ASARCO's Ray Mine in exchange for transferring to the BLM approximately 7,304 acres of private lands, primarily in northwestern Arizona. It is known that at some point ASARCO wishes to develop a copper mining operation in the "Copper Butte" area west of the Ray Mine; however, no details are currently available as to potential environmental effects, including to air quality, resulting from this possible future mining operation. It should be noted that the Copper Butte area lies within current ADEQ nonattainment areas for ozone, lead, and PM_{10}, and that mining development has the potential to generate additional levels of these criteria pollutants.

- *ADOT Vegetation Treatment.* ADOT plans to conduct annual treatments using EPA-approved herbicides to contain, control, or eradicate noxious, invasive, and native plant species that pose safety hazards or threaten native plant communities on road easements and NFS lands up to 200 feet beyond road easement on the Tonto National Forest. It can be reasonably assumed that ADOT would continue to conduct vegetation treatments along U.S. 60 on the Tonto National Forest during the expected life of the Resolution Copper Mine (50 to 55 years) for safety reasons. Activity and traffic could contribute marginally to fugitive dust in the area but would not result in any substantial change when considered with Resolution Copper Project air quality impacts.
- *Tonto National Forest Travel Management Pla*n. The Tonto National Forest is currently in the process of developing a Supplemental EIS to address certain court-identified deficiencies in its 2016 Final Travel Management Rule EIS. This document and its implementing decisions are expected within the next 2 years. The Supplemental EIS currently proposes a total of 3,708 miles of motorized routes open to the public, a reduction from the 4,959 miles of motorized open routes prior to the Travel Management Rule. Limiting availability of motorized routes open to the public would result in reduced access to recreational activities currently practiced on NFS lands, including sightseeing, camping, hiking, hunting, fishing, recreational riding, and collecting fuelwood and other forest products. Such a reduction in miles of available motorized routes should have the effect of leading to overall decrease in emissions and impacts from current levels.

Other mining activity, residential growth, government-sponsored projects and public infrastructure development (including construction of new roadways, electrical transmission lines, and other utilities), agricultural activity, and commercial economic activity is certain to occur in this area of south-central Arizona during the foreseeable future life of the Resolution Copper Mine (50–55 years). Each of these developments may cumulatively contribute to future changes to air quality in the region. Some future expansion or curtailment of presently identified boundaries of nonattainment areas for NAAQS criteria pollutants is also possible, both because of ongoing changes in actual environmental conditions and because the EPA periodically reviews and revises the regulatory standards applicable to these pollutants.

3.6.4.4 Mitigation Effectiveness

The Forest Service is in the process of developing a robust mitigation plan to avoid, minimize, rectify, reduce, or compensate for resource impacts that have been identified during the process of preparing this EIS. Appendix J contains descriptions of mitigation concepts being considered and known to be effective, as of publication of the DEIS. Appendix J also contains descriptions of monitoring that would be needed to identify potential impacts and mitigation effectiveness. As noted in chapter 2 (section 2.3), the full suite of mitigation would be contained in the FEIS, required by the ROD, and ultimately included in the final GPO approved by the Forest Service. Public comment on the EIS, and in particular appendix J, will inform the final suite of mitigations. At this time, no mitigation measures have been identified that would be pertinent to air quality concerns. Applicant-committed environmental protection measures have already been detailed elsewhere in this section, will be a requirement for the project, and have already been incorporated into the analysis.

Unavoidable Adverse Effects

For the proposed action and all alternatives, emissions from project-related activities would meet applicable Federal and State standards for air quality but the increase in air pollutant concentrations would constitute impacts that cannot be avoided.

3.6.4.5 Other Required Disclosures

Short-Term Uses and Long-Term Productivity

Impacts on air quality (increased air pollutant concentrations but below applicable air quality standards) from mining and associated activities would be short term (during the estimated 51- to 56-year life of the mine, including construction, operations, and reclamation) and are expected to end with mine reclamation and return to pre-mining levels, assuming adequate revegetation success to stabilize dust emissions from disturbed areas.

Irreversible and Irretrievable Commitment of Resources

During the construction and mining phases of the project, air pollutant concentrations would be higher throughout the analysis area than current levels but within applicable air quality standards; thus, air quality is not impacted for other uses in the airshed and these effects would not be considered irretrievable. Following mine closure and successful reclamation, pollutant concentrations would return to pre-mining levels, and there would be no long-term irreversible commitment of resources.

Overview

Natural water features are scarce and important to tribes, wildlife, residents, and recreationists. The Resolution Copper Project could affect both water availability and quality in several ways.
In order to construct mine infrastructure, dewatering of the deep groundwater system below Oak Flat began in 2009, and would continue through mining. As the block-caving and subsidence progress, eventually the effects of dewatering would extend to overlying aquifers as well. Changes in these aquifers, as well as capture of runoff by mine facilities and the subsidence area, could in turn affect springs, flowing streams, and riparian areas.
In addition to loss of water, water quality changes could result from stormwater runoff, tailings seepage, or exposure of rock in the block-cave zone.

3.7 Water Resources

3.7.1 Groundwater Quantity and Groundwater-Dependent Ecosystems

3.7.1.1 Introduction

This section describes the analysis and predicted effects on the groundwater dependent ecosystems (GDEs), public and private water supply wells, and subsidence from dewatering.

Resolution Copper has monitored the quantity and quality of water in streams, springs, and riparian areas as far back as 2003, and dozens of wells have been installed for the sole purpose of understanding the local and regional hydrogeology, not just below Oak Flat but throughout the region. To assess impacts on groundwater resources, the long history of baseline data collection was considered holistically alongside

- the large geographic area involved;
- the complex geology and multiple aquifers, including the incorporation of the block-caving itself, which would fundamentally alter the geological structure of these aquifers over time;
- the long time frames involved for mining (decades) as well as the time for the hydrology to adjust to these changes (hundreds of years); and
- the fact that even relatively small changes in water levels can have large effects on natural systems.

A numerical groundwater flow model is the best available tool to assess groundwater impacts.
Like all modeling, the Resolution Copper Mine groundwater model requires great care to construct, calibrate, and properly interpret. The Forest Service collaborated with a broad spectrum of agencies and professionals over several years to assess the groundwater modeling. This diverse group (see section 3.7.1.2) vetted the construction, calibration, and use of the groundwater model, and focused on understanding any sensitive areas with the potential to be negatively affected, including Devil's Canyon, Oak Flat, Mineral Creek, Queen Creek, Telegraph Canyon, Arnett Creek, and springs located across the landscape. The Forest Service refers to such areas as GDEs, which are "communities of plants, animals, and other organisms whose extent and life processes are dependent on access to or discharge of groundwater" (U.S. Forest Service 2012b).

Just as much care was taken to understand the limitations of the groundwater model. Specific model limitations are described in section 3.7.1.2 and reflect a careful assessment of how the results of a groundwater model can reasonably be used, given the uncertainties involved. This reflects a careful assessment of how the results of a groundwater model can reasonably be used, given the uncertainties involved.

The Forest Service undertook a two-part strategy to manage this uncertainty. First, any GDEs were assumed to be connected with the regional aquifers (and therefore potentially affected by the mine) unless direct evidence existed to indicate otherwise. Second, regardless of what the model might predict,

a monitoring plan would be implemented to ensure that actual real-world impacts are fully observed and understood.

This section analyzes impacts on GDEs and local water supplies from dewatering and block-caving, the amount of water that would be used by each alternative, the impacts from pumping of the mine water supply from the Desert Wellfield, and the potential for ground subsidence to occur because of groundwater pumping. Some aspects of the analysis are briefly summarized in this section. Additional details not included here are in the project record (Newell and Garrett 2018d).

3.7.1.2 Analysis Methodology, Assumptions, and Uncertain and Unknown Information

Analysis Area

The analysis area for assessing impacts on groundwater quantity and GDEs comprises the groundwater model boundary for the mine site (figure 3.7.1-1) as well as the groundwater model boundary for the East Salt River valley model (figure 3.7.1-2). Models were run up to 1,000 years in the future, but as described below quantitative results were reasonably applied up to 200 years in the future.

Modeling Process

In September 2017, the Tonto National Forest convened a multidisciplinary team of professionals, referred to as the Groundwater Modeling Workgroup. The Groundwater Modeling Workgroup included Tonto National Forest and Washington-level Forest Service hydrologists, the groundwater modeling experts on the project NEPA team, representatives from ADWR, AGFD, the EPA, the San Carlos Apache Tribe, and Resolution Copper and its contractors. This group included not only hydrologists working on the groundwater model itself, but also the biologists and hydrologists who have conducted monitoring in the field and are knowledgeable about the springs, streams, and riparian systems in the project vicinity. The Groundwater Modeling Workgroup tackled three major tasks: defining sensitive areas, evaluating the model and assisting the Tonto National Forest in making key decisions on model construction and methodology, and assisting the Tonto National Forest in making key decisions on how to use and present model results.

SELECTED MODEL APPROACH

The groundwater model selected for the project is the MODFLOW-SURFACT program, selected in part because of the ability to change aquifer properties over time because of the effects of the block-caving. The assessment of the model by the Groundwater Modeling Workgroup, as well as the assessment of the conceptual hydrologic model upon which the numerical model is based, can be found in the technical memorandum summarizing the workgroup process and conclusions (BGC Engineering USA Inc. 2018a). A description of the model construction can be found in WSP USA (2019). Predictive and sensitivity results can be found in Meza-Cuadra et al. (2018b) and Meza-Cuadra et al. (2018c).

IDENTIFYING AND DEFINING GROUNDWATER-DEPENDENT ECOSYSTEMS

The Groundwater Modeling Workgroup developed the list of GDEs based on multiple sources of information; it ultimately evaluated in detail 67 different locations (Garrett 2018d). Any riparian vegetation or aquatic habitat around the GDEs is considered an integral part of the GDE.

The source of water for each GDE is important. Most of the 67 GDE locations the Groundwater Modeling Workgroup assessed were identified because of the persistent presence of water, year-to-year and season-to-season. In most cases this persistent water suggests a groundwater connection; however, the specific type of groundwater is important for predicting impacts on GDEs. There are generally two regional aquifers in the area: the Apache Leap Tuff, and the deep groundwater system. Any GDEs tied to these two aquifers have the potential to be impacted by mining. The deep groundwater system is being and would continue to be actively dewatered, and once

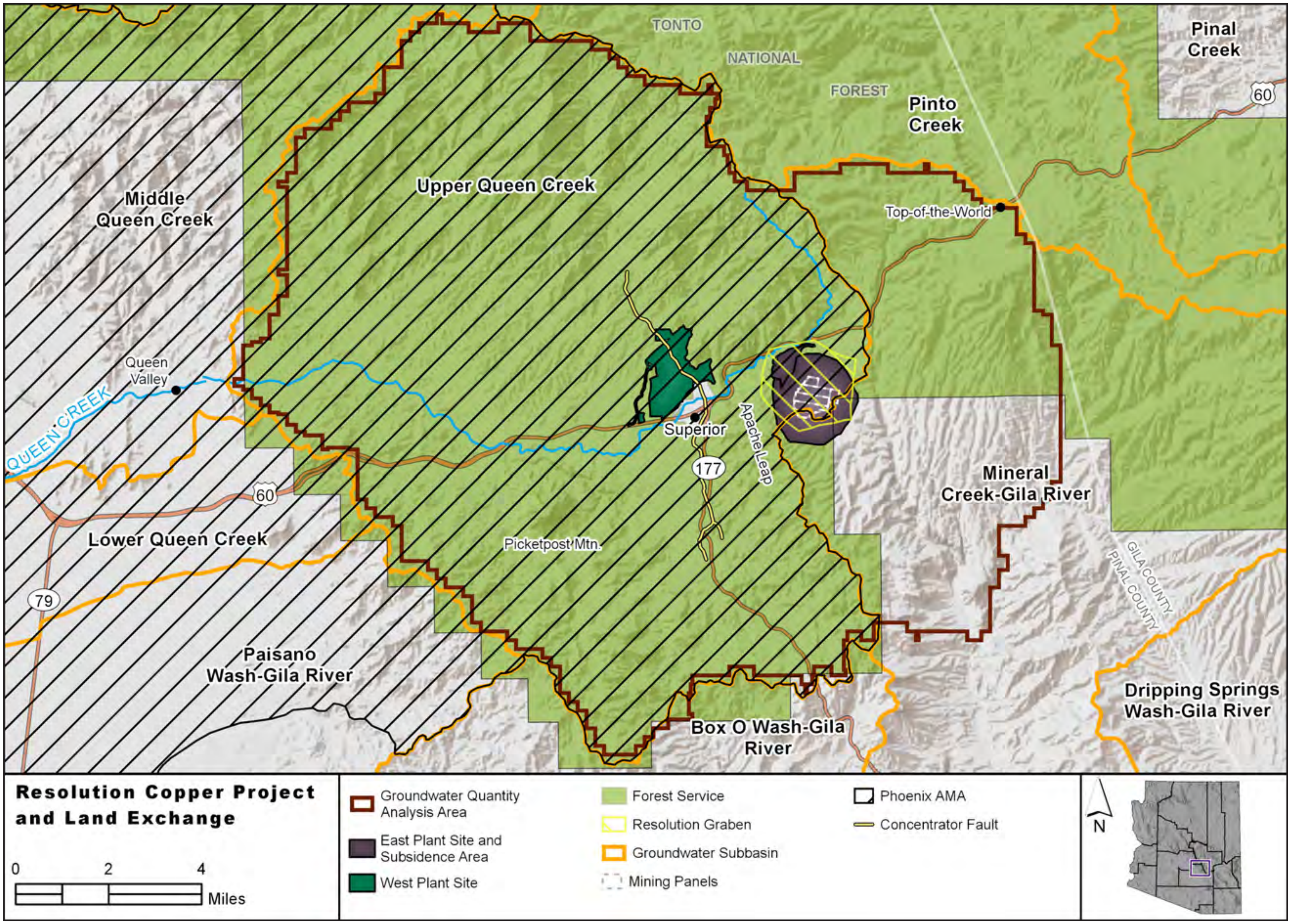


Figure 3.7.1-1. Overview of groundwater modeling analysis area

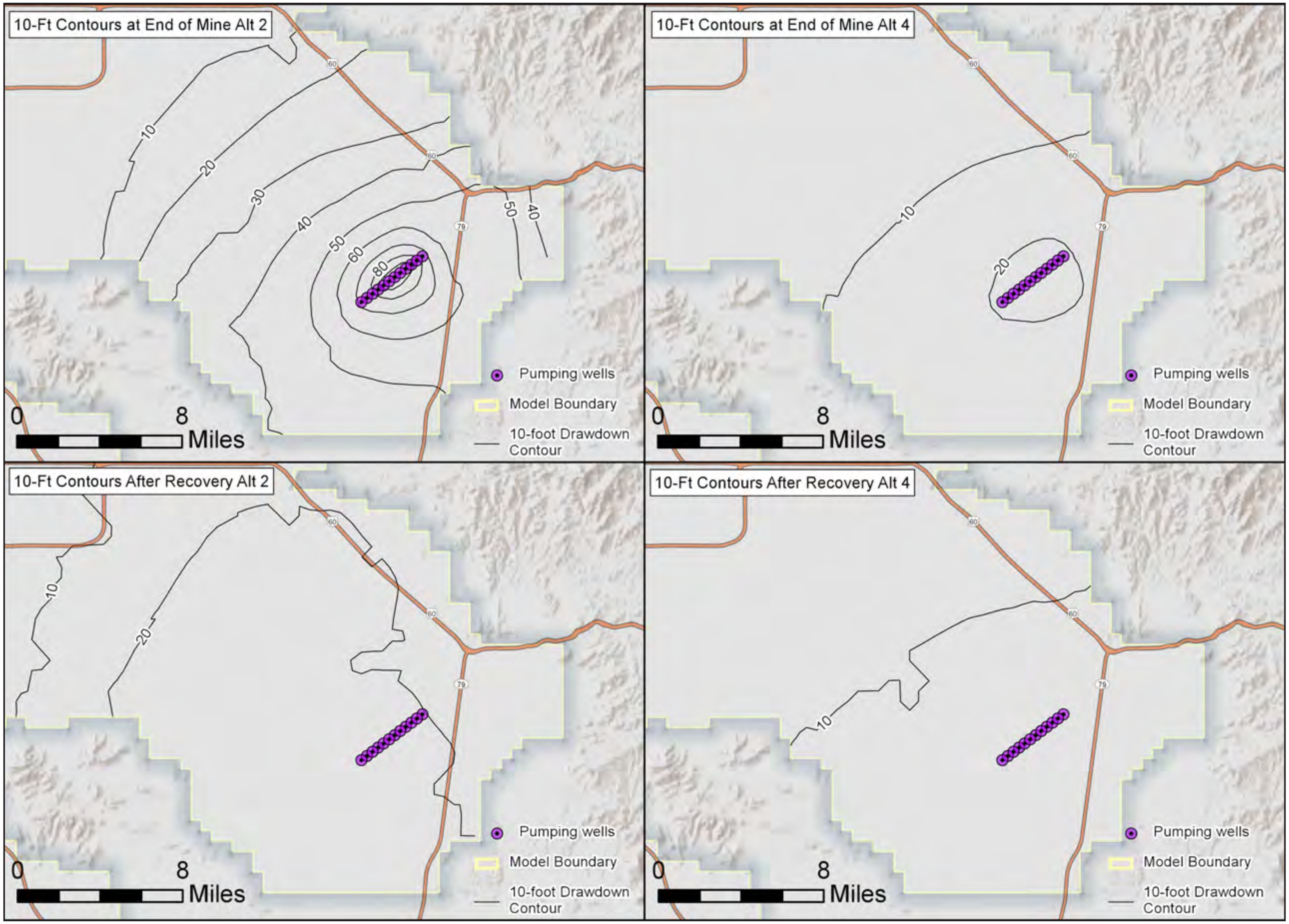


Figure 3.7.1-2. Desert Wellfield modeling analysis area and maximum (Alternative 2, left) and minimum (Alternative 4, right) modeled pumping impacts

block-caving begins the Apache Leap Tuff would begin to dewater as well.

In addition to the regional groundwater systems, another type of groundwater results from precipitation that is temporarily stored in near-surface fractures or alluvial sediments. While temporary, this water still may persist over many months or even years as it slowly percolates back to springs or streams or is lost to evapotranspiration. These near-surface features are perched well above and are hydraulically disconnected from both the Apache Leap Tuff aquifer and the deep groundwater system; therefore, this groundwater source does not have the potential to be impacted by mine dewatering. However, changes in the surface watershed could still affect these shallow, perched groundwater sources. Predictions of reductions in runoff caused by changes in the watershed are discussed in section 3.7.3; these changes are also incorporated into this section (3.7.1) in order to clearly identify all the combined effects that could reduce water available for a GDE.

Identifying whether a GDE derives flow from the deep groundwater system, the Apache Leap Tuff, or shallow, perched aquifers was a key part of the Groundwater Modeling Workgroup's efforts. A number of lines of evidence helped determine the most likely groundwater source for a number of GDEs: hydrologic and geological framework, inorganic water quality, isotopes, riparian vegetation, and the flow rate or presence of water. However, many more GDEs had little or no evidence to consider, or the evidence was contradictory. In these cases the Forest Service policy is to assume that a GDE has the potential to be impacted (Garrett 2018d; Newell and Garrett 2018a). In addition to identifying GDEs, the Groundwater Modeling Workgroup identified three key public water supply areas to assess for potential impacts from the mine.

EVALUATING THE MODEL AND MODELING APPROACH

The Groundwater Modeling Workgroup reviewed the work done by WSP (a contractor of Resolution Copper) and assisted the Tonto National Forest in determining the appropriate methodologies and approaches that should be used. In practice, this consisted of an open, iterative process by which the Groundwater Modeling Workgroup requested data, the data were prepared and presented, and the results and meaning were discussed in Groundwater Modeling Workgroup meetings. All fundamental parts of developing a numerical groundwater flow model were discussed: developing a conceptual model, numerical model construction, model calibration, model sensitivity, model predictive runs, and model documentation. The results and conclusions of the Groundwater Modeling Workgroup's effort are documented in a final Groundwater Modeling Workgroup report (BGC Engineering USA Inc. 2018d).

The conceptual understanding of the hydrogeology and the geological framework of the area is fundamental to developing a valid groundwater flow model. A separate but related workgroup focused specifically on the geological data collection and interpretation, and the subsidence modeling. The results of this workgroup are discussed in Section 3.2, Geology, Minerals, and Subsidence, and documented in a final workgroup report (BGC Engineering USA Inc. 2018a). Several team members collaborated in both workgroups and facilitated sharing of information.

After receiving input from the Groundwater Modeling Workgroup, the Forest Service and its contractors ultimately determined that WSP's groundwater model, as amended and clarified over the course of the workgroup meetings, is a reasonable and appropriate tool for assessing hydrologic changes.

KEY DECISION ON USE OF MODEL RESULTS – BASELINE CONDITIONS

The Groundwater Modeling Workgroup made four specific key decisions about how the groundwater modeling results would be used:

1. Define appropriate baseline conditions,
2. Select an appropriate time frame for model output,
3. Select an appropriate precision for model output, and
4. Develop a strategy to deal with uncertainties.

The first key decision is how potential impacts from the mine operations are to be defined. With many resources, this is a simple task: predicted conditions during or after mine operations are compared with the affected environment, and the difference is considered the "impact" caused by the mine. In this case, renewed dewatering of the deep groundwater system has taken place since 2009 to allow construction and maintenance of mine infrastructure; this is described further in "Current and Ongoing Pumping and Water Level Trends" later in this section. This dewatering pumping is legal and has been properly permitted by the ADWR (see the "Current and Ongoing Pumping and Water Level Trends" section). Resolution Copper is continuing this dewatering and would continue dewatering throughout the mine life. Further, even if the mine is not operated, Resolution Copper would continue legally dewatering to preserve its infrastructure investment.

The Tonto National Forest made the decision to handle this situation in two ways. First, continued dewatering of the mine would be included as part of the no action alternative. Second, the Tonto National Forest is ensuring that any effects of the past dewatering are disclosed as ongoing trends as part of the affected environment (Garrett 2018c).

As such, two separate models were prepared: a No Action model (with continued dewatering, but no block-caving), and a Proposed Action model (with continued dewatering and block-caving as proposed).

- For the no action alternative, the potential impact from the mine is defined as the drawdown as predicted in the no action groundwater flow model, up to 200 years after the start of mining (see next section for discussion on time frames).
- For the action alternatives, the potential impact from the mine is defined as the drawdown predicted in the proposed action groundwater flow model, up to 200 years after the start of mining (see next section for discussion on time frames). However, some of the GDEs impacted by proposed action drawdown would have been impacted by the no action alternative as well. The GDEs anticipated to be impacted by both models are disclosed for comparison, to clearly identify which impacts result from ongoing dewatering alone and which impacts result from the block-caving.

KEY DECISION ON USE OF MODEL RESULTS – TIME FRAME

Groundwater models are generally run until they reach a point where the aquifer has sufficient time to react to an induced stress (in this case, the effects of block-caving) and reach a new point of equilibrium. In some systems this can take hundreds or even thousands of years. The groundwater flow model for the Resolution Copper project was run for 1,000 years, or roughly 950 years after closure of the mine, to approach equilibrium conditions. The Groundwater Modeling Workgroup recognized that a fundamental limitation of the model—of any model—is the unreliability of predictions far in the future, and the workgroup was tasked with determining a time frame that would be reasonable to assess. Based on combined professional judgment, the Groundwater Modeling Workgroup determined that results could be reasonably assessed up to 200 years into the future. All quantitative results disclosed in the EIS are restricted to this time frame.

The Groundwater Modeling Workgroup also recognized that while quantitative predictions over long time frames were not reliable, looking at the general trends of groundwater levels beyond the 200-year time frame still provides valuable context for the analysis. In most cases, the point of maximum groundwater drawdown or impact for any given GDE does not occur at the end of mining. Rather, it takes time for the full impacts to be seen—decades or even centuries. Even if quantitative results are unreliable at long time frames, the general trends in modeled groundwater levels can indicate whether the drawdown or impact reported at 200 years represents a maximum impact, or whether conditions might still worsen at that location. These trends are qualitatively explored, regardless of time frame.

KEY DECISION ON USE OF MODEL RESULTS – LEVEL OF PRECISION

Numerical groundwater models produce highly precise results (i.e., many decimal points). Even in a well-calibrated model, professional hydrologists and modelers recognize that there is a realistic limit to this precision, beyond which results are meaningless. The Groundwater Modeling Workgroup was tasked with determining the appropriate level of precision to use for groundwater modeling results.

Based on combined professional judgment, the Groundwater Modeling Workgroup determined that to properly reflect the level of uncertainty inherent in the modeling effort, results less than 10 feet should not be disclosed or relied upon, as these results are beyond the ability of the model to predict. For values greater than 10 feet, the Groundwater Modeling Workgroup decided to use a series of ranges to further reflect the uncertainty: 10 to 30 feet, 30 to 50 feet, and greater than 50 feet. Regardless of these ranges, the quantitative modeled results for each GDE are still provided in the form of hydrographs (see appendix L). Several strategies were developed to help address the uncertainties associated with the groundwater modeling results, as described in the remainder of this section.

The precision of the results (10 feet) also reflects the inability of a regional groundwater model to fully model the interaction of groundwater with perennial or intermittent streams (see BGC Engineering USA Inc. (2018d) for a full discussion). This limitation means that impacts on surface waters are based on predicted groundwater drawdown, rather than modeled changes in streamflow.

KEY DECISION ON USE OF MODEL RESULTS – STRATEGIES TO ADDRESS UNCERTAINTY

Two key strategies were selected to deal with the uncertainty inherent in the groundwater model: the use of sensitivity model runs and the use of monitoring. The model runs used to predict impacts are based on the best-calibrated version of the model; however, there are many other variations of the model and model parameters that may also be reasonable. Sensitivity model runs are used to understand how other ways of constructing the model change the results. In these sensitivity runs, various model parameters are increased or decreased within reasonable ranges to see how the model outcomes change. In total, 87 model sensitivity runs were conducted, in addition to the best-calibrated version of the model.

Because of the uncertainty and limitations of the model, the Groundwater Modeling Workgroup decided that it would be most appropriate to disclose not only impacts greater than 10 feet based on the best-calibrated model, but also impacts greater than 10 feet based on any of the sensitivity runs. The predicted model results disclosed in this section represent a range of results from the best-calibrated model as well as the full suite of sensitivity runs. These are considered to encompass a reasonable range of impacts that could occur as a result of the project.

As can be seen in figure 3.7.1-3, which shows the 10-foot drawdown contour that encompasses all sensitivity runs (yellow area), some of the sensitivity runs show drawdown abutting the eastern edges of the model domain, which is an undesirable situation for a groundwater model. This result is driven by a single sensitivity run that looked at an increased hydraulic conductivity in the Apache Leap Tuff aquifer. This has been taken into consideration when interpreting the model results. For some GDEs, this particular sensitivity run represents the sole outcome where impact is anticipated; for these, impacts are considered possible but unlikely, given that the base case and all other model sensitivity runs show consistent results.

The Groundwater Modeling Workgroup recognized that while the model may not be reliable for results less than 10 feet in magnitude, changes in aquifer water level much less than 10 feet still could have meaningful effects on GDEs, even leading to complete drying. The Groundwater Modeling Workgroup explored a number of other modeling techniques, including explicitly modeling the interaction between groundwater and surface water to predict small changes in streamflow, but found that these techniques had similar limitations. To address this problem, monitoring of GDEs would be implemented

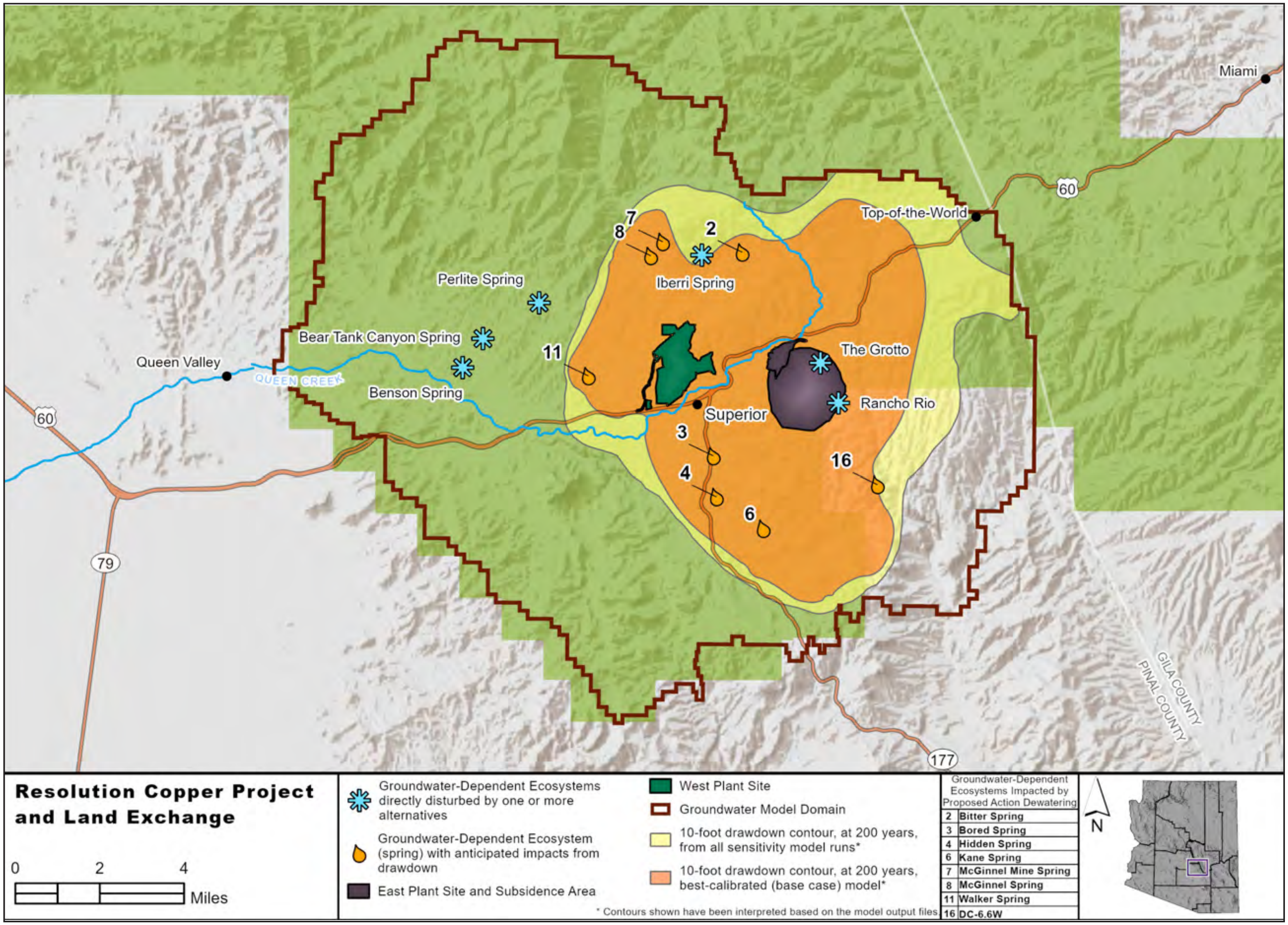


Figure 3.7.1-3. Modeled groundwater drawdown—proposed action, 200 years after start of mine

during mine operations, closure, and potentially beyond. For many of these GDEs, this monitoring effort simply continues monitoring that has been in place from as early as 2003. Details of monitoring conducted to date are available in the project record for springs and surface waters (Montgomery and Associates Inc. 2017d), water quality sampling (Montgomery and Associates Inc. 2016), and well construction and groundwater levels (Montgomery and Associates Inc. and Resolution Copper 2016). If monitoring identifies real-world impacts that were not predicted by the modeling, mitigation would be implemented. Mitigation is not restricted to unanticipated impacts; mitigation may also be undertaken for those GDEs where impacts are expected to occur.

Summary of Models Used for Mine Site Dewatering/Block-Caving Effects

The following groundwater flow models provide the necessary impact predictions. Each of the models included best-calibrated, base-case modeling runs as well as sensitivity runs:

- **No Action model, Life of Mine.** This model assumes that no mining occurs and that therefore no block-caving occurs that connects the Apache Leap Tuff aquifer to the deep groundwater system. While dewatering of the deep groundwater system is assumed to continue, for the most part those dewatering effects are confined to the deep groundwater system, and the Apache Leap Tuff aquifer does not dewater. This model was run for 51 years, until closure of the mine.
- **No Action model, Post-closure.** This model continues after 51 years, with dewatering being curtailed at the end of the Life of Mine model. This model was run to 1,000 years, but quantitative results are only used out to 200 years after start of the model, which is 149 years after closure of the mine. Model results beyond 200 years are still used but are discussed qualitatively.
- **Proposed Action model, Life of Mine.** This model assumes that mining and block-caving occur as proposed, along with the dewatering necessary to maintain project infrastructure. Under these conditions, the Apache Leap Tuff aquifer becomes hydraulically connected to and partially drains downward into the deep groundwater system. This model was run for 51 years, until closure of the mine. The proposed action model is applicable to all action alternatives.
- **Proposed Action model, Post-closure.** This model continues after 51 years, with dewatering being curtailed at the end of the Life of Mine model. This model was run to 1,000 years, but quantitative results are only used out to 200 years after start of the model, which is 149 years after closure of the mine. Model results beyond 200 years are still used but are discussed qualitatively. The proposed action model is applicable to all action alternatives.

Model Used for Mine Water Supply Pumping Effects

One additional model was part of the analysis process. Resolution Copper also ran a model to predict pumping impacts from the water supply wellfield located along the MARRCO corridor in the East Salt River valley. This groundwater flow model was built from an existing, calibrated, regulatory model prepared by ADWR. In some form, this model has been used widely for basin-wide planning purposes since the 1990s, as well as to estimate project-specific water supply impacts, and therefore did not require as extensive a review as the models prepared specifically for the mine. Since the water balance differs greatly between alternatives, due to operations of the tailings facilities, this model was run separately to reflect each of the action alternatives.

3.7.1.3 Affected Environment

Relevant Laws, Regulation, Policies, and Plans

The State of Arizona has jurisdiction over groundwater use; however, the Forest Service also has pertinent guidance on analyzing groundwater

impacts, disclosing these impacts appropriately during NEPA analysis, and managing GDEs on NFS land.

Primary Legal Authorities Relevant to the Groundwater Analysis

- Arizona Groundwater Management Act of 1980, along with implementing regulations that govern groundwater use within Active Management Areas
- Forest Service Manual 2520 (management of riparian areas, wetlands, and floodplains), 2530 (collecting water resource data), and 2880 (inventory and analysis of GDEs)

Existing Conditions and Ongoing Trends

REGIONAL HYDROLOGIC FRAMEWORK

The project is located within a geological region known as the Basin and Range province, near the boundary with another geological region known as the Arizona Transition Zone. The Basin and Range aquifers generally consist of unconsolidated gravel, sand, silt, and clay, or partly consolidated sedimentary or volcanic materials. These materials have filled deep fault-block valleys formed by large vertical displacement across faults. Mountain ranges that generally consist of impermeable rocks separate adjacent valleys (Robson and Banta 1995), leading to compartmentalized groundwater systems. Stream alluvium is present along most of the larger stream channels. These deposits are about 100 feet thick and 1 to 2 miles wide along the Gila, Salt, and Santa Cruz Rivers in Arizona aquifers (Robson and Banta 1995). The hydrology of the Arizona Transition Zone is generally more complex, characterized largely by fractured rock aquifers with some small alluvial basins.

The semiarid climate in the region limits the amount of surface water available for infiltration, resulting in slow recharge of the groundwater with an average annual infiltration of 0.2 to 0.4 inch per year (Woodhouse 1997). Much of this recharge occurs as mountain-front recharge, where runoff concentrates along ephemeral channels.

GROUNDWATER IN THE ANALYSIS AREA

The analysis area contains several distinct groundwater systems, as shown on the conceptual cross section in figure 3.7.1-4:

- Groundwater east of the Concentrator Fault:
    - a shallow, perched groundwater system
    - the Apache Leap Tuff aquifer
    - a deep groundwater system
- Groundwater west of the Concentrator Fault in the Queen Creek watershed:
    - alluvial groundwater, primarily in floodplain alluvium along Queen Creek
    - deep groundwater system in poorly permeable basin-fill sediments

The groundwater underlying most of the analysis area is within the Phoenix AMA, as defined by the Arizona Groundwater Management Act, and is in the East Salt River valley groundwater subbasin of the AMA, as shown in figure 3.7.1-1. Groundwater use within the AMA is administered by the ADWR (Newell and Garrett 2018d).

Summaries of the geology of the area are found in Section 3.2, Geology, Minerals, and Subsidence; the following discussion focuses on the hydrology and groundwater of the area.

East Plant Site

The East Plant Site is located on Oak Flat, east of the Concentrator Fault. The Concentrator Fault is a barrier to flow in the deep groundwater

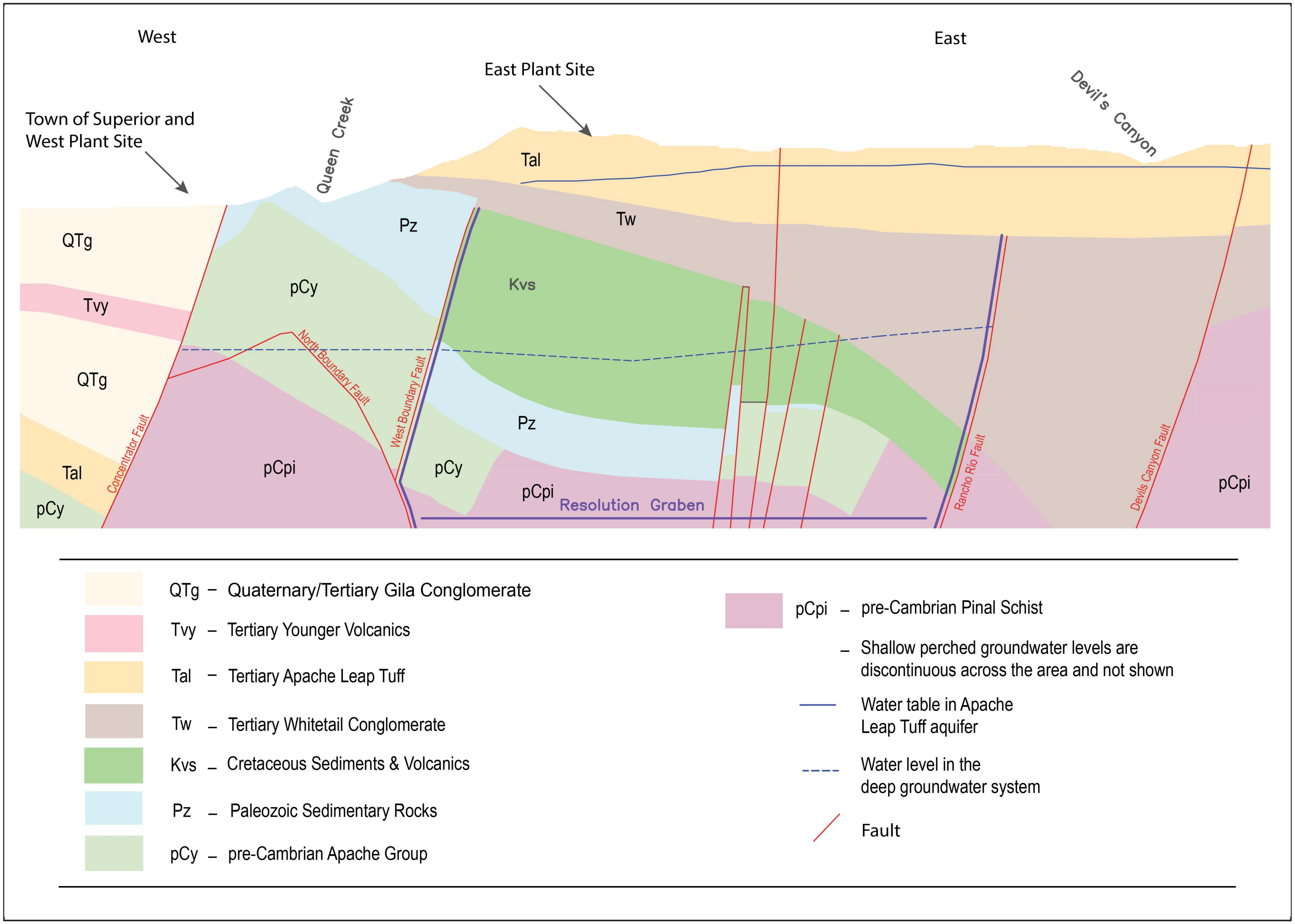


Figure 3.7.1-4. Conceptual cross section of the groundwater systems

systems on either side of the fault. Groundwater characterization wells for the shallow, perched groundwater, the Apache Leap Tuff aquifer, and the deep groundwater system are shown in figure 3.7.1-5.

The shallow groundwater system consists of several shallow, perched aquifers of limited areal extent hosted in alluvial deposits and the uppermost weathered part of the Apache Leap Tuff. The primary shallow aquifers in this area are located near Top-of-the-World and JI Ranch, and to a lesser degree along some of the major drainages such as Hackberry Canyon and Rancho Rio Canyon.

The Apache Leap Tuff aquifer is a fractured-rock aquifer that extends throughout much of the Upper Queen Creek and Devil's Canyon watersheds, and the western part of the Upper Mineral Creek watershed. The Apache Leap Tuff aquifer is separated from the deep groundwater system by a thick sequence of poorly permeable Tertiary basin-fill sediments (the Whitetail Conglomerate). In general, the direction of groundwater movement in the Apache Leap Tuff follows surface drainage patterns, with groundwater moving from areas of recharge at higher elevations to natural discharge areas in Devil's Canyon and in Mineral Creek. Regional water levels in the Apache Leap Tuff aquifer, and general flow directions, are shown in figure 3.7.1-6.

The deep groundwater system east of the Concentrator Fault is compartmentalized, and faults separate individual sections of the groundwater system from each other. Depending on their character, faults can either inhibit or enhance groundwater flow. Based on available evidence, the faults in the project area tend to restrict groundwater flow between individual sections. The ore body and future block-cave zone lie within a geological structure called the Resolution Graben, which is bounded by a series of regional faults. The deep groundwater system in the Resolution Graben is hydraulically connected to existing mine workings, and a clear decrease in water levels in response to ongoing dewatering of the mine workings has been observed (Resolution Copper 2016d).

Three wells monitor the deep groundwater system inside the Resolution Graben (table 3.7.1-1). As noted earlier in this section, groundwater levels in the deep groundwater system below Oak Flat (close to the pumping, within the Resolution Graben) have declined more than 2,000 feet since 2009 (Montgomery and Associates Inc. and Resolution Copper 2016). The deep groundwater system east of the Concentrator Fault, but outside the Resolution Graben, appears to have a limited hydraulic connection with the deep groundwater system inside the graben. Resolution Copper monitors groundwater levels at eight locations in the deep groundwater system outside the Resolution Graben (see table 3.7.1-1). Outside the graben, groundwater level decreases have been smaller, with a maximum decline of about 400 feet since 2009, while near Superior, water levels associated with similar connected units have declined up to 50 feet since 2009 (Montgomery and Associates Inc. and Resolution Copper 2016).

West Plant Site

At the West Plant Site, shallow and intermediate groundwater occurs in the Gila Conglomerate. In addition, groundwater occurs in shallow alluvium to the south of the West Plant Site and in fractured bedrock (Apache Leap Tuff) on the eastern boundary of the West Plant Site.

Groundwater in the shallow, unconfined Gila Conglomerate discharges locally, as evidenced by the presence of seeps and evaporite deposits. The groundwater deeper in the Gila Conglomerate, below a separating mudstone formation, likely flows to the south or southwest toward regional discharge areas (Resolution Copper 2016d). Several wells monitor the Gila Conglomerate near the West Plant Site. Most of these wells have shown steady long-term declines in water level since 1996. These declines are consistent with water level declines occurring regionally in response to drought conditions (Montgomery and Associates Inc. 2017b).

The deep groundwater west of the Concentrator Fault is hosted in low permeability Quaternary and Tertiary basin-fill deposits, fractured Tertiary volcanic rocks, and underlying Apache Leap Tuff. Four wells monitor the deep groundwater system west of the Concentrator Fault. These wells have shown varying rises and declines (Montgomery and Associates Inc. 2017b).

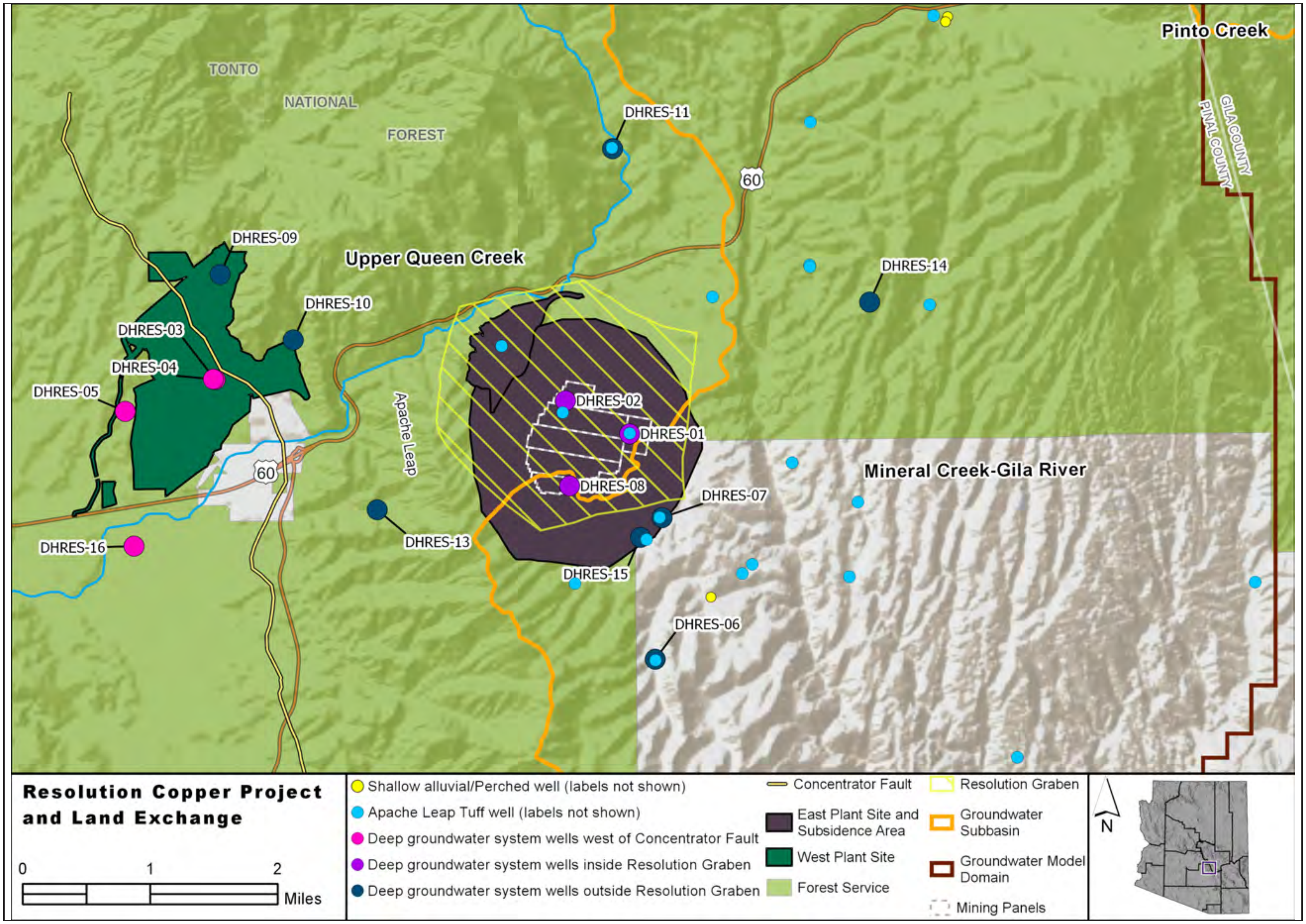


Figure 3.7.1-5. Characterization wells for the shallow, perched groundwater, the Apache Leap Tuff aquifer, and the deep groundwater system

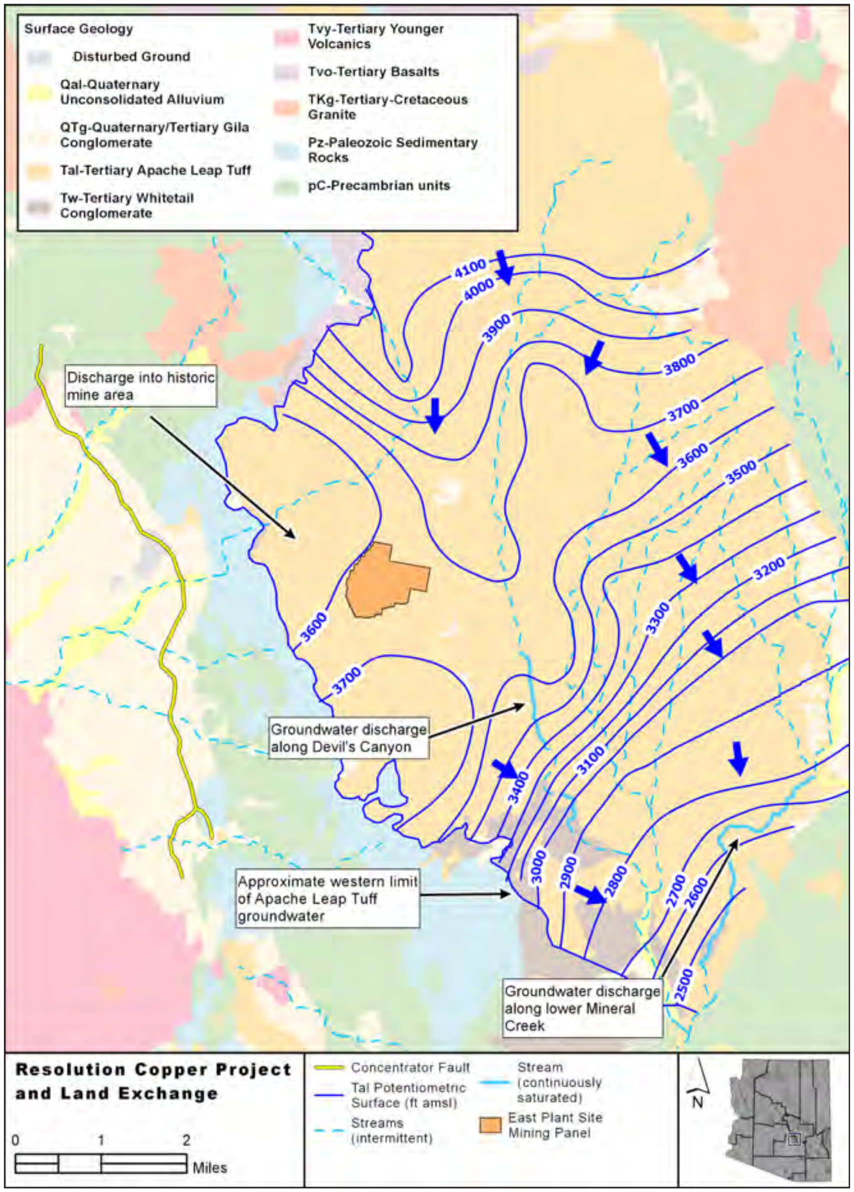


Figure 3.7.1-6. Apache Leap Tuff aquifer water-level elevations and general flow directions

Table 3.7.1-1. Changes in groundwater head in the deep groundwater system due to dewatering

Deep Groundwater System Wells*	Earliest Groundwater Head Elevation, in feet amsl (date shown in parentheses)	Groundwater Head Elevation in 2016 (in feet amsl)	Overall Change (feet)
Deep groundwater system wells: east of the Concentrator Fault within the Resolution Graben			
DHRES-01 (water level in Kvs)	2,090 (2009)	−50	−2,140
DHRES-02 (water level in Kvs)	2,100 (2008)	−380	−2,480
DHRES-08 (DHRES-08_-231 in Kvs)	1,920 (2010)	280	−1,640
Deep groundwater system wells: east of the Concentrator Fault outside of the Resolution Graben			
DHRES-06 (water level in Pz [Pnaco, Me, Dm, Cb, pCdiab])	3,254 (2010)	3,242	−12
DHRES-07 (DHRES-07_-108 in Pz [Cb])	3,000 (2010)	2,890	−110
DHRES-09 (water level in pCdsq and pCdiab)	2,990 (2011)	2,944	−46
DHRES-10	N/A	N/A	N/A
DHRES-11 (water level in Pz and pCy)	3,300 (2011)	2,940	−360
DHRES-13 (water level in pCy and pCpi)	2,790 (2011)	2,704	−86
DHRES-14 (water level in Tw and pCpi)	3,508 (2012)	3,484	−24
DHRES-15 (water level in Dm and Cb)	3,210 (2015)	3,240	+30
Deep groundwater system wells: west of the Concentrator Fault			
DHRES-03 (DHRES-03_335 in Tvs)	2,526 (2009)	2,496	−30
DHRES-04 (water level in Tvs)	2,570 (2009)	2,600	+30
DHRES-05B (water level in Tal)	2,620 (2010)	2,578	−42
DHRES-16 (DHRES-16_-387 in Tal)	2,316 (2014)	2,268	−48

Source: All data taken from Montgomery and Associates Inc. and Resolution Copper (2016)

Notes: Some elevations approximated to nearest 10 feet for clarity. N/A = Data not available; amsl = above mean sea level

Tal = Apache Leap Tuff; Tw = Whitetail conglomerate; Tvs = Tertiary sedimentary and volcanic rocks; Kvs = Cretaceous sedimentary and volcanic rocks; Pz = Paleozoic sedimentary rocks (Pnaco = Naco formation; Me = Escabrosa limestone; Dm = Martin formation; Cb = Bolsa quartzite);
pCy = Precambrian Apache Group; pCdiab = Precambrian diabase; pCdsq = Precambrian Dripping Springs quartzite; pCpi = Precambrian Pinal schist

* For wells with multiple monitoring depths, specific monitoring location is shown in parentheses

MARRCO Corridor, Filter Plant and Loadout Facility, and Desert Wellfield

Along much of the MARRCO corridor, groundwater is present in a shallow aquifer within the alluvium along Queen Creek. The groundwater flow direction in this part of the corridor generally follows the Queen Creek drainage to the west.

In the portion of the corridor between Florence Junction and Magma, where the filter plant and loadout facility would be located, the groundwater is present in deep alluvial units. The regional groundwater flow direction in this area is generally toward the northwest (Resolution Copper 2016d).

The makeup water supply[36] for the mine would come from a series of wells installed within the MARRCO corridor, drawing water from these deep alluvial units of the East Salt River valley. These wells are known as the “Desert Wellfield.” Although groundwater development in the vicinity of the Desert Wellfield has heretofore been limited, historically areas of the East Salt River valley to the west and south have been heavily used for agriculture. Until the late 1980s to early 1990s, groundwater levels were declining in much of the basin. Passage of the 1980 Groundwater Management Act which imposed limits on pumping, the availability of a renewable source of water, and the development of a regulatory framework allowing for recharge of the aquifer, all of which in combination with reduced agricultural pumping, have contributed to rising water levels. In the New Magma Irrigation and Drainage District (NMIDD) to the southwest, groundwater levels have recovered on the order of 170 feet over the past three decades, with somewhat lesser water level increases occurring in the area of the Desert Wellfield (Bates et al. 2018). Current depths to groundwater in the vicinity of the Desert Wellfield range from 400 to 600 feet below ground surface.

Tailings Storage Facility – Alternatives 2 and 3 – Near West

Thin alluvial deposits on the floors of canyons and washes at the location of the proposed tailings storage facility contain small amounts of shallow, perched groundwater. The majority of the tailings storage facility site is underlain by rocks with little permeability, with no indication of a water We are doing it. LOL. within the upper 150 to 300 feet of ground surface (Montgomery and Associates Inc. 2017c). Where those rocks are fractured, they have the potential to store groundwater and allow for groundwater flow. Three springs are in the footprint of the proposed tailings storage facility: the Perlite, Benson, and Bear Tank Canyon Springs (see figure 3.7.1-3). Groundwater flow generally follows the topography toward Queen Creek. Several wells were installed in the tailings storage facility area to provide information on groundwater levels (Montgomery and Associates Inc. 2017c).

Tailings Storage Facility – Alternative 4 – Silver King

Similar to the Near West site, thin alluvial deposits on the floors of canyons and washes, especially in Silver King Wash, contain small amounts of shallow, perched groundwater (Cross and Blainer-Fleming 2012; Klohn Crippen Berger Ltd. 2018c). The majority of the tailings storage facility site is underlain by rocks with little permeability. Groundwater moves generally southwest (Cross and Blainer-Fleming 2012). A number of perennial springs are located near Alternative 4. McGinnel Spring and Iberri Spring are located within the footprint of Alternative 4, and several other perennial springs (McGinnel Mine Spring, Rock Horizontal Spring, and Bitter Spring) are located within 1 mile (see figure 3.7.1-3).

Tailings Storage Facility – Alternative 5 – Peg Leg

A broad alluvial groundwater basin underlies the Peg Leg location (Ludington et al. 2007). Limited site water level data suggest

36. The mine process incorporates numerous means of recycling water back into the process wherever possible. However, for all alternatives, there remains the need for substantial additional fresh water for the processing. The fresh water fed into the processing stream is termed “makeup” water.

that groundwater depths below the facility footprint are relatively shallow, with depths less than 50 feet (Golder Associates Inc. 2018a). Groundwater flow is to the northwest, generally following the ground surface topography. The site is located in the Donnelly Wash groundwater basin, outside of any AMA.

Tailings Storage Facility – Alternative 6 – Skunk Camp

Deposits of sand and gravel less than 150 feet thick underlie the Skunk Camp location and contain shallow groundwater (Klohn Crippen Berger Ltd. 2018d). Regional groundwater is assumed to flow from northwest to southeast within the proposed tailings storage facility area toward the Gila River. Shallow groundwater flow is expected to be primarily through the surface alluvial channels and upper weathered zone of the Gila Conglomerate (Klohn Crippen Berger Ltd. 2018d). The site is located in the Dripping Spring Wash groundwater basin, outside of any AMA.

GROUNDWATER BALANCE WITHIN MODELING ANALYSIS AREA

Groundwater systems are considered to be at steady state when outflow equals inflow. In the modeling analysis area, outflows due to mine dewatering exceed inflows, with the result that the groundwater system is not at steady state and water is removed from storage.

Inflow components of the groundwater balance include recharge from precipitation, groundwater inflows from adjacent groundwater basins, and deep percolation from irrigation and from the Town of Superior Wastewater Treatment Plant. Recharge from precipitation is the largest component of inflow into the groundwater of the analysis area.

Groundwater outflows include mine dewatering, groundwater pumping, subsurface and surface flow at Whitlow Ranch Dam (a flood control structure located on Queen Creek, just upstream of the community of Queen Valley), and groundwater evapotranspiration.

The largest component of groundwater outflow for both the shallow perched groundwater and the Apache Leap Tuff aquifer is groundwater evapotranspiration, primarily from where vegetation has access to near-surface groundwater. The largest component of groundwater outflow for deep groundwater is mine dewatering, primarily from Resolution Copper but also from an open-pit perlite mining operation near Queen Creek. In 2017, mine dewatering removed approximately 1,360 acre-feet of water from the deep groundwater system (Montgomery and Associates Inc. 2018).

ONGOING CLIMATIC TRENDS AFFECTING WATER BALANCE

The annual mean and minimum temperatures in the lower Colorado River Basin have increased 1.8 degrees Fahrenheit (°F) to 3.6°F for the time period 1900–2002, and data suggest that spring minimum temperatures for the same time period have increased 3.6°F to 7.2°F (Dugan 2018). Winter temperatures have increased up to 7.2°F, and summer temperatures 1.6°F. Increasing temperature has been correlated with decreasing snowpack and earlier runoff in the lower Colorado River Basin, with runoff increasing between November and February and decreasing between April and July (April to July is traditionally recognized as the peak runoff season in the basin).

Future projected temperature increases are anticipated to change the amount of precipitation only by a small amount but would change the timing of runoff and increase the overall evaporative demand. Groundwater recharge is most effective during low-intensity, long-duration precipitation events, and when precipitation falls as snow. With ongoing trends for the southwestern United States toward higher temperatures with less snow and more high-intensity rainstorms, more runoff occurs, but groundwater recharge may decline, leading to a decrease in groundwater levels. Increased demand for groundwater, due to higher water demand under higher temperatures, may also lead to greater stresses on groundwater supplies.

CURRENT AND ONGOING PUMPING AND WATER LEVEL TRENDS

Mining near Superior started about 1875, and dewatering of the Magma Mine began in earnest in 1910 as production depths increased. Dewatering continued with little interruption until 1998, after active mining ceased at the Magma Mine. In 2009, Resolution Copper resumed dewatering as construction began on Shaft 10 (WSP USA 2019). Since 2009, Resolution Copper has reported pumping about 13,000 acre-feet of groundwater under their dewatering permit.[37] Almost all of this water is treated and delivered to the NMIDD. Most historical dewatering pumping took place east of the Concentrator Fault, primarily at the Magma Mine, but also at the Silver King, Lake Superior and Arizona, and Belmont mines (Keay 2018).

Resolution Copper removes groundwater from sumps in Shafts 9 and 10, effectively dewatering the deep groundwater system that lies below the Whitetail Conglomerate unit (the bottom of Shaft 10 is about 7,000 feet below ground level). Groundwater levels in the deep groundwater system below Oak Flat (close to the pumping) have dropped over 2,000 feet since 2009. These same hydrogeological units extend west, below Apache Leap, and into the Superior Basin. Near Superior, water levels associated with these units have declined roughly 20 to 90 feet since 2009 (Montgomery and Associates Inc. and Resolution Copper 2016).

In the Oak Flat area, the Apache Leap Tuff aquifer overlies the deep groundwater system, and the Whitetail Conglomerate unit separates the two groundwater systems. The Whitetail Conglomerate unit acts as an aquitard—limiting the downward flow of groundwater from the Apache Leap Tuff. Groundwater level changes in the Apache Leap Tuff that have been observed have generally been 10 feet or less since 2009.

Groundwater levels in the Apache Leap Tuff are important because they provide water to GDEs, such as the middle and lower reaches of Devil's Canyon (Garrett 2018d). Resolution Copper has extensively monitored Devil's Canyon since as early as 2003. Most hydrologic indicators show no significant change over time in Devil's Canyon (Garrett 2019d). A number of other water sources have been monitored on Oak Flat and show seasonal drying, but these locations have been demonstrated to be disconnected from the Apache Leap Tuff aquifer, relying instead on localized precipitation (Garrett 2018d; Montgomery and Associates Inc. 2017a). Other pumping also occurs within the Superior Basin, but is substantially less than the Resolution Copper dewatering, roughly accounting for less than 10 percent of groundwater pumped within the model area (Montgomery and Associates Inc. 2018).

GROUNDWATER-DEPENDENT ECOSYSTEMS

The Tonto National Forest evaluated 67 different spring or stream locations in the project area as potential GDEs. These include the following:

- **Queen Creek watershed.** Areas evaluated include Queen Creek itself from its headwaters to Whitlow Ranch Dam, four tributaries (Number Nine Wash, Oak Flat Wash, Arnett Creek, and Telegraph Canyon), and 29 spring locations.
- **Devil's Canyon watershed.** Areas evaluated include Devil's Canyon from its headwaters to the confluence with Mineral Creek at the upper end of Big Box Reservoir, three tributaries (Hackberry Canyon, Rancho Rio Canyon, and Iron Canyon), and seven spring locations. Four of these springs are located along the main stem of Devil's Canyon and contribute to the general streamflow.
- **Mineral Creek watershed.** Areas evaluated include Mineral Creek from its headwaters to the confluence with Devil's Canyon at the upper end of Big Box Reservoir, and five spring locations. Three of these springs are located along the main stem of Mineral Creek and contribute to the general streamflow.

37. The current mine infrastructure lies almost entirely within the Phoenix AMA. In this area, pumping groundwater requires a groundwater right from the ADWR. Resolution Copper's dewatering right (59-524492) is permitted through 2029 (Rietz 2016b).

After evaluating available lines of evidence for portions of Queen Creek, Devil's Canyon, Mineral Creek, Telegraph Canyon, and Arnett Creek, the Groundwater Modeling Workgroup thought it likely that some stream segments within these watersheds could have at least a partial connection to regional aquifers, and each is described in more detail in the following text of this section. In addition, the Groundwater Modeling Workgroup identified 17 springs that they believe have at least a partial connection to regional aquifers. The remainder of the potential GDEs were eliminated from analysis for various reasons (Garrett 2018d).[38] GDEs with a likely or possible regional groundwater source, and therefore analyzed in this section, are listed in table 3.7.1-2 and shown in figure 3.7.1-7.

Devil's Canyon

The upper reach of Devil's Canyon (from above the U.S. 60 bridge to approximately km 9.3) includes a reach of perennial flow from approximately DC-11.0 to DC-10.6. The geohydrology suggests that this section of Devil's Canyon lies above the water table in the Apache Leap Tuff aquifer and is most likely supported by snowmelt or precipitation stored in near-surface fractures, and/or floodwaters that have been stored in shallow alluvium along the stream, before slowly draining into the main channel. Further evaluation of hydrochemistry and flow data support this conclusion (Garrett 2018d). Streamflow in Upper Devil's Canyon is not considered to be connected with the regional Apache Leap Tuff aquifer and would not be expected to be impacted by groundwater drawdown caused by the block-cave mining and dewatering. This portion of Devil's Canyon is also upstream of the subsidence area and unlikely to be impacted by changes in surface runoff.

Moving downstream in Devil's Canyon, persistent streamflow arises again about km 9.3. From this point downstream, Devil's Canyon contains stretches of perennial flow, aquatic habitat, and riparian galleries. Flow arises both from discrete springs along the walls of the canyon (four total), as well as groundwater inflow along the channel bottom. These reaches of Devil's Canyon also are supported in part by near-surface storage of seasonal precipitation; however, the available evidence indicates that these waters arise primarily from the regional Apache Leap Tuff aquifer. Streamflow in middle and lower Devil's Canyon is considered to be connected with the regional aquifer, which could potentially be impacted by groundwater drawdown caused by the block-cave mining and dewatering. These reaches of Devil's Canyon also receive runoff from the area where the subsidence area would occur and therefore may also lose flow during runoff events.

Queen Creek

The available evidence suggests that Queen Creek from headwaters to Whitlow Ranch Dam is ephemeral in nature, although in some areas above Superior it may be considered intermittent, as winter base flow does occur and likely derives from seasonal storage of water in streambank alluvium, which slowly seeps back in to the main channel (Garrett 2018d). This includes three springs located along the main stem of Queen Creek above Superior.

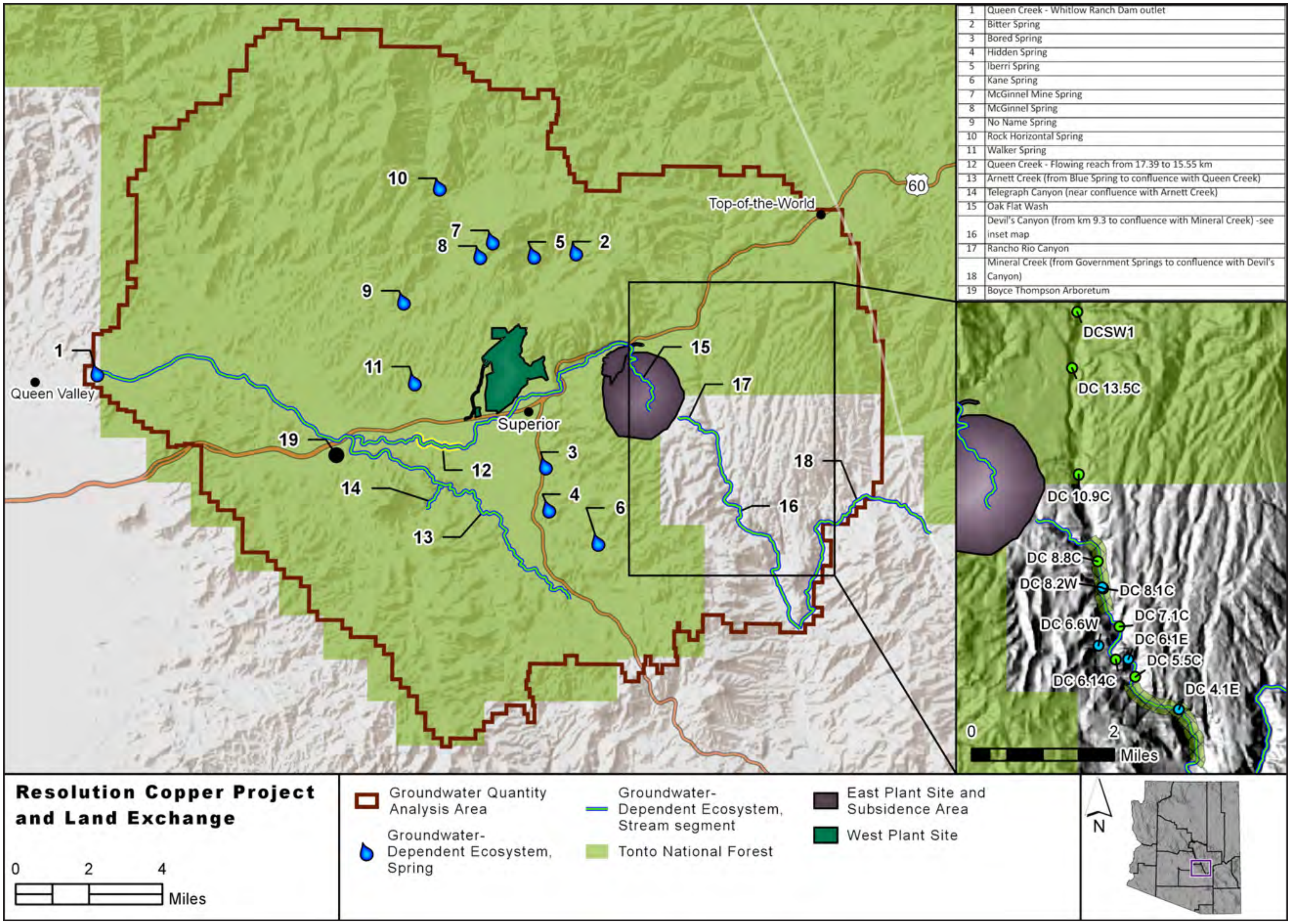
An exception for Queen Creek is a perennially flowing reach between km 17.39 and 15.55, which is located downstream of Superior and upstream of Boyce Thompson Arboretum. Originally this flowing reach had been discounted because it receives effluent discharge from the Superior Wastewater Treatment Plant. However, discussions within the Groundwater Modeling Workgroup suggested that a component of baseflow supported by regional aquifer discharge may exist in this reach as well. Regardless of whether baseflow directly enters the channel from the regional aquifer, substantial flow in this reach also derives from dewatering discharges from a small open-pit perlite mining operation, where the mine pit presumably intersects the regional aquifer

38. To summarize, potential GDEs were eliminated from analysis using the groundwater flow model because they did not appear to exist within the analysis area (five springs); or had sufficient evidence to indicate a shallow groundwater source instead of a connection to the regional aquifers (19 springs; most of Queen Creek; upper Devil's Canyon; two tributaries to Queen Creek; and three tributaries to Devil's Canyon). Some of these GDEs may still be affected by changes in surface runoff, and these changes are still analyzed in this section.

Table 3.7.1-2. GDEs identified as having at least a partial connection to regional groundwater

Type of Feature	Name/Description*	Type of Impact Analysis Used in EIS
Queen Creek Watershed		
Stream segments	Queen Creek, between km 17.39 and 15.55 (downstream of Superior and upstream of Boyce Thompson Arboretum); approximately 1.2 miles long Queen Creek at Whitlow Ranch Dam Arnett Creek, near the confluence with Telegraph Canyon (km 4.5) and upstream at Blue Spring (km 12.5) Telegraph Canyon, near the confluence with Arnett Creek	Groundwater flow model (all stream segments); Surface water flow model (Queen Creek only)
Springs (10 total)	Bitter, Bored, Hidden, Iberri, Kane, McGinnel, McGinnel Mine, No Name, Rock Horizontal, and Walker	Groundwater flow model
Devil's Canyon Watershed		
Stream segments	Devil's Canyon, from km 9.14 to confluence with Mineral Creek/Big Box Reservoir; approximately 5.7 miles long	Groundwater flow model; Surface flow water model
Springs (4 total)	DC-8.2W, DC-6.6W, DC-6.1E, DC-4.1E	Groundwater flow model
Mineral Creek Watershed		
Stream segments	Mineral Creek from km 8.7 to confluence with Devil's Canyon/Big Box Reservoir, approximately 5.4 miles long	Groundwater flow model
Springs (3 total)	Government Springs, MC-8.4C, MC-3.4W (Wet Leg Spring)	Groundwater flow model

* Many of the stream descriptions reference the distance upstream of the confluence, measured in kilometers. This reference system is also incorporated into many stream/spring monitoring locations. For instance, spring "DC-8.4W" is located 8.4 km upstream of the mouth of Devil's Canyon, on the west side of the drainage.



1	Queen Creek - Whitlow Ranch Dam outlet
2	Bitter Spring
3	Bored Spring
4	Hidden Spring
5	Iberri Spring
6	Kane Spring
7	McGinnel Mine Spring
8	McGinnel Spring
9	No Name Spring
10	Rock Horizontal Spring
11	Walker Spring
12	Queen Creek - Flowing reach from 17.39 to 15.55 km
13	Arnett Creek (from Blue Spring to confluence with Queen Creek)
14	Telegraph Canyon (near confluence with Arnett Creek)
15	Oak Flat Wash
16	Devil's Canyon (from km 9.3 to confluence with Mineral Creek) -see inset map
17	Rancho Rio Canyon
18	Mineral Creek (from Government Springs to confluence with Devil's Canyon)
19	Boyce Thompson Arboretum

Figure 3.7.1-7. Groundwater-dependent ecosystems of concern

(Garrett 2018d). Therefore, for several reasons, this reach was included as a potential GDE, with the potential to be impacted by regional groundwater drawdown. The AGFD conducted surveys on this reach in 2017 and found that while flow fluctuated throughout the survey reach, aquatic wildlife and numerous other avian and terrestrial species use this habitat, and that aquatic species appeared to be thriving and reproducing (Warnecke et al. 2018).

Queen Creek also has perennial flow that occurs at Whitlow Ranch Dam and supports a 45-acre riparian area (primarily cottonwood, willow, and saltcedar). This location is generally considered to be where most subsurface flow in the alluvium along Queen Creek and other hydrologic units exits the Superior Basin. Queen Creek above and below Superior receives runoff from the area where the subsidence area would occur and therefore may also lose flow during runoff events. Runoff from over 20 percent of the Queen Creek watershed above Magma Avenue Bridge would be lost to the subsidence area (described in more detail in Section 3.7.3, Surface Water Quantity).

Mineral Creek

Mineral Creek is similar in nature to lower Devil's Canyon. While flows are supported in part by near-surface storage of seasonal precipitation, the available evidence indicates that these waters arise partially from the Apache Leap Tuff aquifer and other regional sources. For the purposes of analysis, Mineral Creek is considered to be connected with regional aquifers, which could potentially be impacted by groundwater drawdown caused by the block-cave mining and dewatering; whether this impact is predicted to occur or not is determined using the results of the groundwater modeling.

Approximately the lower 4 miles of Mineral Creek exhibits perennial flow that supports riparian galleries and aquatic habitat. Three perennial springs also contribute to Mineral Creek (Government Springs, MC-8.4C, and MC-3.4W or Wet Leg Spring). Government Springs is the farthest upstream, roughly 5.4 miles above the confluence with Devil's Canyon (Garrett 2018d).

Mineral Creek is designated as critical habitat for Gila chub. The AGFD has conducted fish surveys on Mineral Creek periodically since 2000 and has not identified Gila chub in Mineral Creek since 2000. While the presence of amphibians suggested acceptable water quality in this reach, until 2006 no fish populations were observed despite acceptable habitat. AGFD stocked native longfin dace in Mineral Creek downstream of Government Springs in 2006, and as of 2017, these fish were still present in the stream, though Gila chub have not been seen (Crowder et al. 2014; WestLand Resources Inc. 2018a).

Arnett Creek

Fairly strong and consistent evidence indicates that several reaches of Arnett Creek likely receive some contribution from groundwater that looks similar to the Apache Leap Tuff aquifer, though these units are not present in this area. This includes Blue Spring (located in the channel of Arnett Creek above Telegraph Canyon) and in the downstream portions of Arnett Creek immediately downstream of Telegraph Canyon. Arnett Creek is considered to be connected with regional aquifers, which could potentially be impacted by groundwater drawdown caused by the block-cave mining and dewatering; whether this impact is predicted to occur or not is determined using the results of the groundwater modeling.

Telegraph Canyon

Telegraph Canyon is a tributary to Arnett Creek. Unlike Arnett Creek, there was insufficient evidence to determine whether or not these waters were tied to the regional aquifers. In such cases, the Forest Service policy is to assume that a connection exists; therefore, Telegraph Canyon is also considered to be connected with the regional aquifers, which could potentially be impacted by groundwater drawdown caused by the block-cave mining and dewatering; whether this impact is predicted to occur or not is determined using the results of the groundwater modeling.

Tributaries to Queen Creek and Devil's Canyon

A number of tributaries were evaluated originating in the Oak Flat area and feeding either Queen Creek or Devil's Canyon. These include Number 9 Wash and Oak Flat Wash (Queen Creek watershed) and Iron Canyon, Hackberry Canyon, and Rancho Rio Canyon (Devil's Canyon watershed). Sufficient evidence existed for all of these tributaries to demonstrate that they most likely have local water sources that are not connected to the regional Apache Leap Tuff aquifer (Garrett 2018d).

WATER SUPPLY WELLS

GDEs represent natural systems that could be impacted by the project, but human communities also rely on groundwater sources in the area. In lieu of analyzing individual wells, typical wells in key communities were analyzed using the groundwater flow model (Newell and Garrett 2018d). These areas include the following:

- **Top-of-the-World.** Many wells in this location are relatively shallow and rely on near-surface fracture systems and shallow perched alluvial deposits (see Garrett (2018d), Attachment 7); these wells would not be impacted by changes in the regional aquifers. However, other wells in this area could be completed deeper into the Apache Leap Tuff aquifer. Impacts on well HRES-06 is used as a proxy for potential impacts on water supplies and individual wells in this area.
- **Superior.** The Arizona Water Company serves the Town of Superior; the water comes from the East Salt River valley. Even so, there are assumed to still be individual wells within the town that use local groundwater (stock wells, domestic wells, commercial wells). As with Top-of-the-World, some of these wells may rely on near-surface groundwater and would not be impacted by changes in the regional aquifers. Other wells could be completed in geological units in hydraulic connection to the deep groundwater system. Well DHRES-16_743 is used as a proxy for potential impacts on water supplies and individual wells in this area.
- **Boyce Thompson Arboretum.** The Gallery Well is used as a proxy for impacts on water supplies associated with Boyce Thompson Arboretum. This well likely uses groundwater from local sources, but for the purposes of analysis it is assumed to be connected to regional aquifers.

3.7.1.4 Environmental Consequences of Implementation of the Proposed Mine Plan and Alternatives

Alternative 1 – No Action

ANTICIPATED IMPACTS ON GDES (UP TO 200 YEARS)

Under the no action alternative, which includes continued dewatering pumping of the deep groundwater system, no perennial streams are anticipated to be impacted, but six perennial springs experience drawdown greater than 10 feet. These springs are Bitter, Bored, Hidden, McGinnel, McGinnel Mine, and Walker Springs, as shown in figures 3.7.1-8 and 3.7.1-9, and summarized in table 3.7.1-3. Hydrographs showing drawdown under the no action alternative for all GDEs with connections to regional aquifers are included in appendix L.

The 10-foot drawdown contour shown on figure 3.7.1-8 represents the limit of where the groundwater model can reasonably predict impacts with the best-calibrated model (orange area). GDEs falling within this contour are anticipated to be impacted. GDEs outside this contour may still be impacted, but it is beyond the ability of the model to predict.

It is not possible to precisely predict what impact a given drawdown in groundwater level would have on an individual spring; however, given the precision of the model (10 feet), it is reasonable to assume any spring with anticipated impact of this magnitude could experience complete drying.

Bored Spring has the highest riparian value, supporting a standing pool and a 500-foot riparian string of cottonwood, willow, mesquite,

Table 3.7.1-3. Summary of potential impacts on groundwater-dependent ecosystems from groundwater drawdown

Reference Number on Figure 3.7.1-7	Specific GDE	Drawdown (feet) from Dewatering under No Action Alternative (end of mining)	Drawdown (feet) from Dewatering and Block-Cave under Proposed Action (end of mining)	Drawdown (feet) from Dewatering under No Action Alternative (200 years after start of mine)	Drawdown (feet) from Dewatering and Block-Cave under Proposed Action (200 years after start of mine)	Number of Sensitivity Runs with Drawdown greater than 10 Feet (based on Proposed Action, 200 yearsafter start of mine)	Summary of Expected Impacts on GDEs
	Queen Creek and Tributaries						
12	Queen Creek – Flowing reach from km 17.39 to 15.55	<10	<10	<10	<10	4 of 87 sensitivity runs show impacts greater than 10 feet; impacts are possible but unlikely	No Action – Drawdown is not anticipated.* Proposed Action – Additional drawdown due to block-caving is not anticipated with the base case model. Drawdown is possible but unlikely under the sensitivity modeling runs.* Reach has two other documented and substantial water sources.
1	Queen Creek – Whitlow Ranch Dam Outlet‡	<10	<10	<10	<10	Not available	No Action – Drawdown is not anticipated.* Proposed Action – Additional drawdown due to block-caving is not anticipated.†
13	Arnett Creek (from Blue Spring to confluence with Queen Creek)	<10	<10	<10	<10	0 of 87 sensitivity runs show impacts greater than 10 feet	No Action – Drawdown is not anticipated.* Proposed Action – Additional drawdown due to block-caving is not anticipated.*
14	Telegraph Canyon (near confluence with Arnett Creek)	<10	<10	<10	<10	0 of 87 sensitivity runs show impacts greater than 10 feet	No Action – Drawdown is not anticipated.* Proposed Action – Additional drawdown due to block-caving is not anticipated.*
	Devil's Canyon and Springs along Channel						

continued

Table 3.7.1-3. Summary of potential impacts on groundwater-dependent ecosystems from groundwater drawdown *(cont'd)*

Reference Number on Figure 3.7.1-7	Specific GDE	Drawdown (feet) from Dewatering under No Action Alternative (end of mining)	Drawdown (feet) from Dewatering and Block-Cave under Proposed Action (end of mining)	Drawdown (feet) from Dewatering under No Action Alternative (200 years after start of mine)	Drawdown (feet) from Dewatering and Block-Cave under Proposed Action (200 years after start of mine)	Number of Sensitivity Runs with Drawdown greater than 10 Feet (based on Proposed Action, 200 yearsafter start of mine)	Summary of Expected Impacts on GDEs
16	Middle Devil's Canyon (from km 9.3 to km 6.1, including springs DC8.2W, DC6.6W, and DC6.1E)	<10	<10	<10	10–30 (Spring DC-6.6W)	For spring DC6.6W, 76 of 87 sensitivity runs show impacts greater than 10 feet; confirms base case impacts For the main channel (DC8.8C, DC 8.1C) and spring DC8.2W, 1 of 87 sensitivity runs shows impacts greater than 10 feet; impacts are possible but unlikely For spring DC6.1E, 0 of 87 sensitivity runs show impacts greater than 10 feet	No Action – Drawdown is not anticipated.* Proposed Action – Addition drawdown due to block-caving is anticipated in spring DC-6.6W with the base case model and most sensitivity modeling runs (see description of impacts).*† Drawdown is possible but unlikely under the sensitivity modeling runs for main channel groundwater inflow and spring DC6.1E.2
16	Lower Devil's Canyon (from km 6.1 to confluence with Mineral Creek, including spring DC4.1E)	<10	<10	<10	<10	0 of 87 sensitivity runs show impacts greater than 10 feet	No Action – Drawdown is not anticipated.* Proposed Action – Additional drawdown due to block-caving is not anticipated.*
	Mineral Creek and Springs along Channel						

continued

Table 3.7.1-3. Summary of potential impacts on groundwater-dependent ecosystems from groundwater drawdown *(cont'd)*

Reference Number on Figure 3.7.1-7	Specific GDE	Drawdown (feet) from Dewatering under No Action Alternative (end of mining)	Drawdown (feet) from Dewatering and Block-Cave under Proposed Action (end of mining)	Drawdown (feet) from Dewatering under No Action Alternative (200 years after start of mine)	Drawdown (feet) from Dewatering and Block-Cave under Proposed Action (200 years after start of mine)	Number of Sensitivity Runs with Drawdown greater than 10 Feet (based on Proposed Action, 200 yearsafter start of mine)	Summary of Expected Impacts on GDEs
18	Mineral Creek (from Government Springs [km 8.7] to confluence with Devil's Canyon, including springs MC8.4C and MC3.4W [Wet Leg Spring])	<10	<10	<10	<10	0 of 87 sensitivity runs show impacts greater than 10 feet	No Action – Drawdown is not anticipated.* Proposed Action – Additional drawdown due to block-caving is not anticipated.*
	Queen Creek Basin Springs						
2	Bitter Spring	10–30	10–30	<10	10–30	87 of 87 sensitivity runs show impacts greater than 10 feet; confirms base case impacts	No Action – Drawdown is anticipated (see description of impacts).*† Proposed Action – Additional drawdown due to block-caving is anticipated (see description of impacts).*†
3	Bored Spring	30–50	30–50	>50	>50	87 of 87 sensitivity runs show impacts greater than 10 feet; confirms base case impacts	No Action – Drawdown is anticipated (see description of impacts).*† Proposed Action – Additional drawdown due to block-caving is anticipated (see description of impacts).*†

continued

Table 3.7.1-3. Summary of potential impacts on groundwater-dependent ecosystems from groundwater drawdown *(cont'd)*

Reference Number on Figure 3.7.1-7	Specific GDE	Drawdown (feet) from Dewatering under No Action Alternative (end of mining)	Drawdown (feet) from Dewatering and Block-Cave under Proposed Action (end of mining)	Drawdown (feet) from Dewatering under No Action Alternative (200 years after start of mine)	Drawdown (feet) from Dewatering and Block-Cave under Proposed Action (200 years after start of mine)	Number of Sensitivity Runs with Drawdown greater than 10 Feet (based on Proposed Action, 200 yearsafter start of mine)	Summary of Expected Impacts on GDEs
4	Hidden Spring	10–30	10–30	30–50	>50	87 of 87 sensitivity runs show impacts greater than 10 feet; confirms base case impacts	No Action – Drawdown is anticipated (see description of impacts).*† Proposed Action – Additional drawdown due to block-caving is anticipated (see description of impacts).*†
5	Iberri Spring	<10	<10	<10	<10	1 of 87 sensitivity runs show impacts greater than 10 feet; impacts are possible but unlikely	No Action – Drawdown is not anticipated.* Proposed Action – Addition drawdown due to block-caving is not anticipated with the base case model. Drawdown is possible but unlikely under the sensitivity modeling runs.*
6	Kane Spring	<10	<10	<10	>50	84 of 87 sensitivity runs show impacts greater than 10 feet; confirms base case impacts	No Action – Drawdown is not anticipated.* Proposed Action – Additional drawdown due to block-caving is anticipated (see description of impacts).*†
7	McGinnel Mine Spring	<10	<10	10–30	10–30	86 of 87 sensitivity runs show impacts greater than 10 feet; confirms base case impacts	No Action – Drawdown is anticipated (see description of impacts).*† Proposed Action – Addition drawdown due to block-caving is anticipated (see description of impacts).*†

continued

Table 3.7.1-3. Summary of potential impacts on groundwater-dependent ecosystems from groundwater drawdown *(cont'd)*

Reference Number on Figure 3.7.1-7	Specific GDE	Drawdown (feet) from Dewatering under No Action Alternative (end of mining)	Drawdown (feet) from Dewatering and Block-Cave under Proposed Action (end of mining)	Drawdown (feet) from Dewatering under No Action Alternative (200 years after start of mine)	Drawdown (feet) from Dewatering and Block-Cave under Proposed Action (200 years after start of mine)	Number of Sensitivity Runs with Drawdown greater than 10 Feet (based on Proposed Action, 200 yearsafter start of mine)	Summary of Expected Impacts on GDEs
8	McGinnel Spring	<10	<10	10–30	10–30	85 of 87 sensitivity runs show impacts greater than 10 feet; confirms base case impacts	No Action – Drawdown is anticipated (see description of impacts).*† Proposed Action – Addition drawdown due to block-caving is anticipated (see description of impacts).*†
9	No Name Spring	<10	<10	<10	<10	0 of 87 sensitivity runs show impacts greater than 10 feet	No Action – Drawdown is not anticipated.* Proposed Action – Additional drawdown due to block-caving is not anticipated.*
10	Rock Horizontal Spring	<10	<10	<10	<10	0 of 87 sensitivity runs show impacts greater than 10 feet	No Action – Drawdown is not anticipated.* Proposed Action – Additional drawdown due to block-caving is not anticipated.*
11	Walker Spring	10–30	10–30	10–30	30–50	87 of 87 sensitivity runs show impacts greater than 10 feet; confirms base case impacts	No Action – Drawdown is anticipated (see description of impacts).*† Proposed Action – Additional drawdown due to block-caving is anticipated (see description of impacts).*†

* Regardless of anticipated impacts, monitoring would occur during operations for verification. Predictions of drawdown are approximations of a complex physical system, inherently limited by the quality of input data and structural constraints imposed by the model grid and modeling approach. The groundwater model does not predict changes to flow magnitude and timing at a given GDE. By extension, drawdown contours may not represent the aerial extent of anticipated impacts on GDEs. These contours will be used to inform more site-specific impact monitoring and mitigation.

† For all springs, streams, and associated riparian areas potentially impacted, impacts could include a reduction or loss of spring/stream flow, increased mortality or reduction in extent or health of riparian vegetation, and reduction in the quality or quantity of aquatic habitat from loss of flowing water, adjacent vegetation, or standing pools.

‡ Whitlow Ranch Dam outlet is not modeled specifically, as this cell is defined by a constant head in the model. Output described is based on estimated head levels at this location.

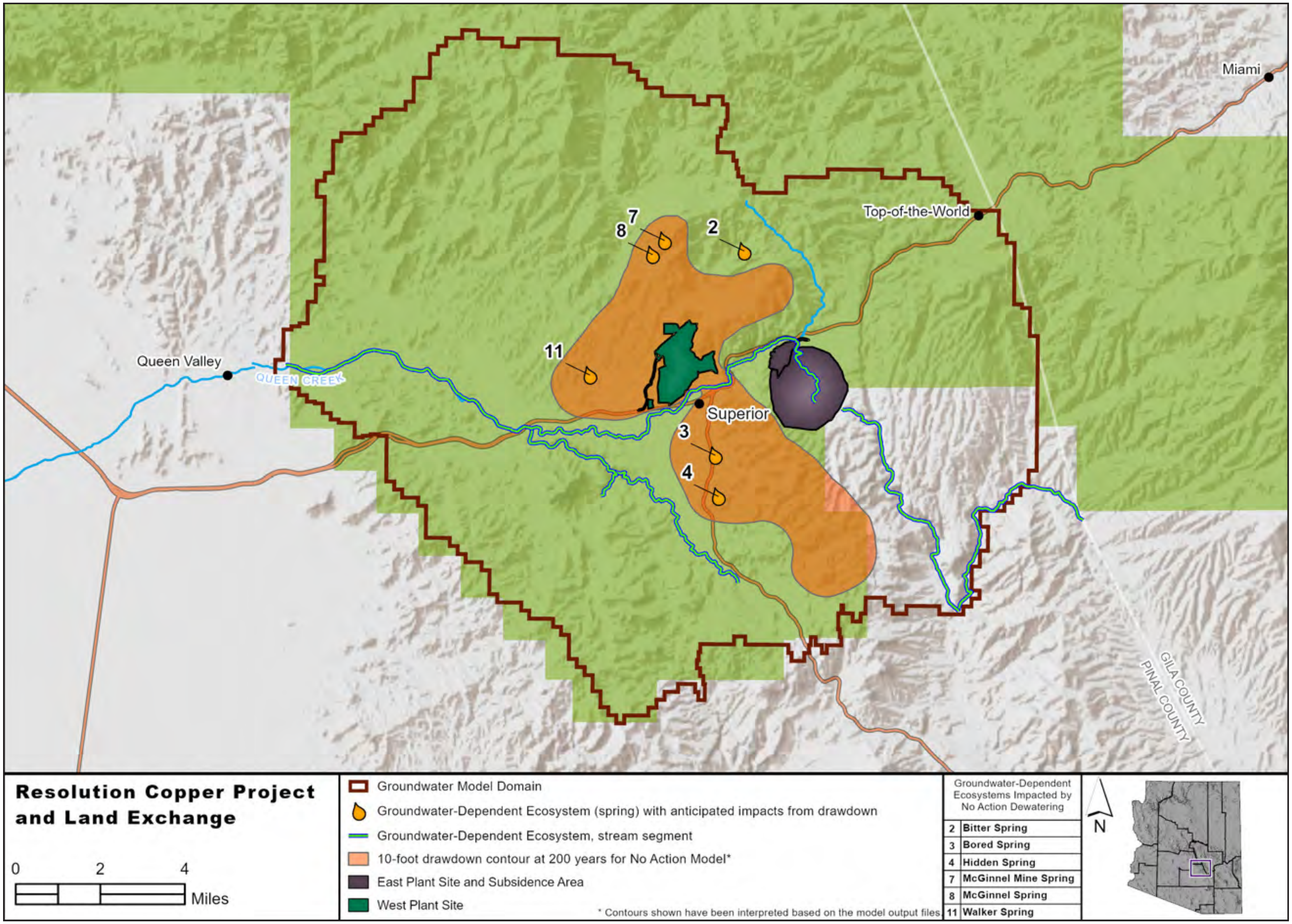


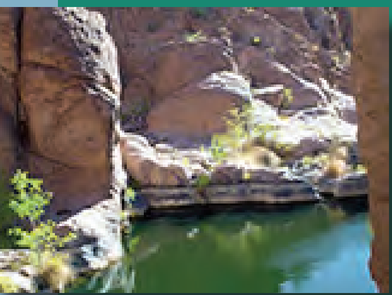
Figure 3.7.1-8. Modeled groundwater drawdown—no action

Impacts to GDEs

No Action

Continued Dewatering

- Bitter Spring
- Bored Spring
- Hidden Spring
- McGinnel Mine Spring
- McGinnel Spring
- Walker Spring



All Action Alternatives

Best-calibrated Model (Impacts are anticipated)	• DC-6.6W Spring • Kane Spring
All Sensitivity Model Runs (Impacts are possible)	• No Additional GDEs
All Sensitivity Runs (Impacts are possible but unlikely)*	• Middle Devil's Canyon (DC-8.8C, DC-8.82W, DC-8.1C) • Queen Creek (17.4-15.6) • Iberri Spring

* Totals shown do not include GDEs with "possible but unlikely" impacts; while at least one model sensitivity run indicates impacts could happen to these GDEs, the great majority of model runs indicate otherwise.

Alternatives

	Subsidence Crater Alone	Alt 2/3 (Near West)	Alt 4 (Silver King)	Alt 5 (Peg Leg)	Alt 6 (Skunk Camp)
Direct Disturbance	• Grotto • Rancho Rio	• Benson • Bear Canyon • Perlite	• Iberri • McGinnel	• None	• None
Surface Water Reductions	• Queen Creek (17.4-15.6) • Queen Creek (Whitlow Ranch Dam) • Devil's Canyon	• Queen Creek (Whitlow Ranch Dam)	• Queen Creek (Whitlow Ranch Dam)	• Gila River	• Gila River
Total GDEs Impacted†		16	14	14	14

† Totals shown include both GDEs impacted by the subsidence crater and GDEs impacted by specific alternatives.

Figure 3.7.1-9. Summary of impacts on GDEs by alternative

saltcedar, and sumac. The loss of water to this spring would likely lead to complete loss of this riparian area.

Bitter, Hidden, McGinnel, McGinnel Mine, and Walker Springs all have infrastructure improvements to some degree and host relatively little riparian vegetation, although standing water and herbaceous and wetland vegetation may be present. The loss of flowing water would likely lead to complete loss of these pools and fringe vegetation.

ANTICIPATED IMPACTS ON WATER SUPPLY WELLS

Many domestic and stock water supply wells in the area are shallow and likely make use of water stored in shallow alluvium or shallow fracture networks. These wells are unlikely to be impacted by groundwater drawdown from mine dewatering under the no action alternative. However, groundwater drawdown caused by the mine could affect groundwater supplies for wells that may draw from either the regional Apache Leap Tuff aquifer or the deep groundwater system. Drawdown from 10 to 30 feet is anticipated in wells in the Superior area, as shown in table 3.7.1-4.

Unlike the action alternative, the applicant-committed environmental protection measures that would remedy any impacts on water supply wells caused by drawdown from the project (discussed later in this section) would not occur under the no action alternative.

LONGER TERM MODELED IMPACTS

The only GDEs impacted under the no action alternative are the six distant springs identified earlier in this section, which are modeled as having connections to the regional deep groundwater system. Based on long-term modeled hydrographs, these springs generally see maximum drawdown resulting from the continued mine pumping within 150 to 200 years after the end of mining; the impacts shown in table 3.7.1-3 likely represent the maximum impacts that would be experienced under the no action scenario.

SUBSIDENCE IMPACTS

Under the no action alternative, small amounts of land surface displacement could continue to occur due to ongoing pumping (Newell and Garrett 2018d). These amounts are observable using satellite monitoring techniques but are unlikely to be observable on the ground.

Impacts Common to All Action Alternatives

EFFECTS OF THE LAND EXCHANGE

The land exchange would have effects on groundwater quantity and GDEs.

The Oak Flat Federal Parcel would leave Forest Service jurisdiction. Several GDEs were identified on the Oak Flat Federal Parcel, including Rancho Rio Canyon, Oak Flat Wash, Number 9 Wash, the Grotto (spring), and Rancho Rio spring. The role of the Tonto National Forest under its primary authorities in the Organic Administration Act, Locatable Regulations (36 CFR 228 Subpart A), and Multiple-Use Mining Act is to ensure that mining activities minimize adverse environmental effects on NFS surface resources; this includes these GDEs. The removal of the Oak Flat Federal Parcel from Forest Service jurisdiction negates the ability of the Tonto National Forest to regulate effects on these resources.

The offered lands parcels would enter either Forest Service or BLM jurisdiction. A number of perennial water features are located on these lands, including the following:

- Tangle Creek. Features of the Tangle Creek Parcel include Tangle Creek and one spring (LX Spring). Tangle Creek is an intermittent or perennial tributary to the Verde River and bisects the parcel. It includes associated riparian habitat with mature hackberry, mesquite, ash, and sycamore trees.
- Turkey Creek. Features of the Turkey Creek Parcel include Turkey Creek, which is an intermittent or perennial tributary to Tonto Creek and eventually to the Salt River at Roosevelt

Table 3.7.1-4. Summary of potential impacts on groundwater supplies from groundwater drawdown

Water Supply Area	Drawdown (feet) from Dewatering under No Action Alternative (end of mining)	Drawdown (feet) from Dewatering and Block-Cave under Proposed Action (end of mining)	Drawdown (feet) from Dewatering under No Action Alternative (200 years after start of mine)	Drawdown (feet) from Dewatering and Block-Cave under Proposed Action (200 years after start of mine)	Potential for Greater Drawdown Based on Sensitivity Runs?	Summary of Expected Impacts on Groundwater Supplies
DHRES-16_743 (Superior)	<10	10–30	<10	10–30	86 of 87 sensitivity runs show impacts greater than 10 feet; confirms base case impacts	No Action – Drawdown is not anticipated. Proposed Action – Additional drawdown due to block-caving is anticipated for water supply wells in this area, except for those completed solely in alluvium or shallow fracture systems. Impacts could include loss of well capacity, the need to deepen wells, the need to modify pump equipment, or increased pumping costs. Applicant-committed remedy if impacts occur.
Gallery Well (Boyce Thompson Arboretum)	<10	<10	<10	<10	0 of 87 sensitivity runs show impacts greater than 10 feet	No Action – Drawdown is not anticipated. Proposed Action – Additional drawdown due to block-caving is not anticipated.
HRES-06 (Top-of-the-World)	<10	<10	<10	<10	17 of 87 sensitivity runs show impacts greater than 10 feet; impacts are possible beyond base case impacts	No Action – Drawdown is not anticipated. Proposed Action – Additional drawdown due to block-caving is anticipated for water supply wells in this area, except for those completed solely in alluvium or shallow fracture systems. Impacts could include loss of well capacity, the need to deepen wells, the need to modify pump equipment, or increased pumping costs. Applicant-committed remedy if impacts occur.

Lake. Riparian vegetation occurs along Turkey Creek with cottonwood, locus, sycamore, and oak trees.

- Cave Creek. Features of the Cave Creek Parcel include Cave Creek, an ephemeral to intermittent tributary to the Agua Fria River, with some perennial reaches in the vicinity of the parcel.
- East Clear Creek. Features of the East Clear Creek Parcel include East Clear Creek, a substantial perennial tributary to the Little Colorado River. Riparian vegetation occurs along East Clear Creek, including boxelder, cottonwood, willow, and alder trees.
- Lower San Pedro River. Features of the Lower San Pedro River Parcel include the San Pedro River and several large, ephemeral tributaries (Cooper, Mammoth, and Turtle Washes). The San Pedro River itself is ephemeral to intermittent along the 10-mile reach that runs through the parcel; some perennial surface water is supported by an uncapped artesian well. The San Pedro is one of the few remaining free-flowing rivers in the Southwest and it is recognized as one of the more important riparian habitats in the Sonoran and Chihuahuan Deserts. The riparian corridor in the parcel includes more than 800 acres of mesquite woodlands that also features a spring-fed wetland.
- Appleton Ranch. The Appleton Ranch Parcels are located along ephemeral tributaries to the Babocomari River (Post, Vaughn, and O'Donnel Canyons). Woody vegetation is present along watercourses as mesquite bosques, with very limited stands of cottonwood and desert willow.
- No specific water sources have been identified on the Apache Leap South Parcel or the Dripping Springs Parcel.

Specific management of water resources on the offered lands would be determined by the agencies, but in general when the offered lands enter Federal jurisdiction, these water sources would be afforded a level of protection they currently do not have under private ownership.

EFFECTS OF FOREST PLAN AMENDMENT

The Tonto National Forest Land and Resource Management Plan (1985b) provides guidance for management of lands and activities within the Tonto National Forest. It accomplishes this by establishing a mission, goals, objectives, and standards and guidelines. Missions, goals, and objectives are applicable on a forest-wide basis. Standards and guidelines are either applicable on a forest-wide basis or by specific management area.

A review of all components of the 1985 Forest Plan was conducted to identify the need for amendment due to the effects of the project, including both the land exchange and the proposed mining plan of operations (Shin 2019). A number of standards and guidelines (16) were identified applicable to management of groundwater resources. None of these standards and guidelines were found to require amendment to the proposed project, either on a forest-wide or management area-specific basis. For additional details on specific rationale, see Shin (2019).

SUMMARY OF APPLICANT-COMMITTED ENVIRONMENTAL PROTECTION MEASURES

A number of environmental protection measures are incorporated into the design of the project that would act to reduce potential impacts on groundwater quantity and GDEs. These are non-discretionary measures and their effects are accounted for in the analysis of environmental consequences.

From the GPO (2016d), Resolution Copper has committed to various measures to reduce impacts on groundwater quantity and GDEs:

- Groundwater levels will be monitored at designated compliance monitoring wells located downstream of the tailings storage facility seepage recovery embankments in accordance with the requirements of the APP program;
- All potentially impacted water will be contained on-site during operations and will be put to beneficial use, thereby reducing the need to import makeup water;

- Approximately one-half of Resolution Copper's water needs will be sourced from long-term storage credits (surface stored underground);
- As much water as possible will be recycled for reuse; and
- The water supply will also include the beneficial reuse of existing low-quality water sources such as impacted underground mine dewatering water.

HYDROLOGIC CHANGES ANTICIPATED FROM MINING ACTIVITIES

The block-caving conducted to remove the ore body would unavoidably result in fracturing and subsidence of overlying rocks. These effects would propagate upward until reaching the ground surface approximately 6 years after block-caving begins (Garza-Cruz and Pierce 2017). It is estimated that the subsidence area that would develop at the surface would be approximately 800 to 1,100 feet deep (see Section 3.2, Geology, Minerals, and Subsidence).

Fracturing and subsidence of rock units would extend from the ore body to the surface. This includes fracturing of the Whitetail Conglomerate that forms a barrier between the deep groundwater system and the Apache Leap Tuff aquifer. When the Whitetail Conglomerate fractures and subsides, a hydraulic connection is created between all aquifers. Effects of dewatering from the deep groundwater system would extend to the Apache Leap Tuff aquifer at this time.

CHANGES IN BASIN WATER BALANCE – MINE DEWATERING

Mine dewatering is estimated to remove approximately 87,000 acre-feet of water from the combined deep groundwater system and Apache Leap Tuff aquifer over the life of the mine, or about 1,700 acre-feet per year (Meza-Cuadra et al. 2018a).

ANTICIPATED IMPACTS FOR GDES (UP TO 200 YEARS AFTER START OF MINING)

As assessed in this EIS, GDEs can be impacted in a number of ways:

- Ongoing dewatering (described in the no action alternative section)
- Expansion of dewatering impacts caused by the block-caving (described in this section)
- Direct physical disturbance by either the subsidence area or tailings storage facilities (described in following sections for each individual alternative)
- Reduction in surface flow from loss of watershed due to subsidence area or tailings facility (described in section 3.7.3 and also summarized in this section)

Six springs experienced drawdown greater than 10 feet under the no action alternative, and these springs are also impacted under the proposed action (Bitter, Bored, Hidden, McGinnel, McGinnel Mine, and Walker Springs). Under the proposed action, the hydrologic changes caused by the block-caving would allow the dewatering impacts to expand, impacting two additional springs: Kane Spring and DC6.6W. Impacts on springs under the proposed action are summarized in table 3.7.1-3 and figure 3.7.1-9 and are shown along with the model results (10-foot drawdown contour) in figure 3.7.1-3. Hydrographs of drawdown under the proposed action for all GDEs are also included in appendix L.

As one strategy to address the uncertainty inherent in the groundwater model, sensitivity modeling runs were also considered in addition to the base case model. The sensitivity modeling runs strongly confirm the impacts on the eight springs listed earlier in this section. Sensitivity runs show additional impact could be possible in Middle Devil's Canyon (locations DC8.8C, DC8.2CW, and DC8.1C), in Queen Creek below Superior, and at Iberri Spring. In each case, however, the large majority of sensitivity runs are consistent with the base case modeling and show

drawdown less than 10 feet. Based on the sensitivity runs, impacts at these locations may be possible but are considered unlikely.

The 10-foot drawdown contour shown on figure 3.7.1-3 represents the limit of where the groundwater model can reasonably predict impacts, either with the best-calibrated model (orange area) or the model sensitivity runs (yellow area). GDEs falling within this contour are anticipated to be impacted. GDEs outside this contour may still be impacted, but it is beyond the ability of the model to predict.

ANTICIPATED IMPACTS ON DEVIL'S CANYON

Groundwater inflow along the main stem of Devil's Canyon is not anticipated to be impacted using the best-calibrated groundwater model; however, tributary flow from spring DC-6.6W along the western edge of Devil's Canyon is anticipated to be impacted. Based on field measurements, flow from this spring contributes up to 5 percent of flow in the main channel downstream at location DC-5.5C (Newell and Garrett 2018d). There is little indication that any other springs along Devil's Canyon or groundwater contribution to the main stem of the stream would be impacted; out of 87 modeling runs, only a single modeling run indicates impact on GDE locations in Devil's Canyon besides spring DC-6-6W.

Potential runoff reductions in Devil's Canyon are summarized in table 3.7.1-5. Percent reductions in average annual flow due to the subsidence area range from 5.6 percent in middle Devil's Canyon to 3.5 percent at the confluence with Mineral Creek; percent reductions during the critical low-flow months of May and June are approximately the same. Combined with loss from spring DC-6.6W due to groundwater drawdown, total estimated flow reductions along the main stem of lower Devil's Canyon caused by the proposed project could range from 5 to 10 percent.

The habitat in Devil's Canyon downstream of spring DC-6.6W and the subsidence area that would potentially lose flow includes a roughly 2.1-mile-long, 50-acre riparian gallery, and a 0.5-mile-long continuously saturated reach that includes several large perennial pools. Riparian vegetation in this portion of the canyon ranges from 40 to 300 feet wide. Dominant riparian species are sycamore, cottonwood, ash, alder, and willow, as well as wetland species at spring locations.

The anticipated 5 to 10 percent loss in flow during the dry season could contribute to a reduction in the extent and health of riparian vegetation and aquatic habitat. Complete drying of the downstream habitat, loss of dominant riparian vegetation, or loss of standing pools would be unlikely.

ANTICIPATED IMPACTS ON SPRINGS

It is not possible to precisely predict what impact a given drawdown in groundwater level would have on an individual spring; however, given the precision of the model (10 feet), it is reasonable to assume any spring with anticipated impact of this magnitude could experience complete drying.

Bored Spring has the highest riparian value, supporting a standing pool and a 500-foot riparian string of cottonwood, willow, mesquite, saltcedar, and sumac. The loss of water to this spring would likely lead to complete loss of this riparian area.

Hidden, McGinnel, McGinnel Mine, Walker, Bitter, and Kane Springs all have infrastructure improvements to some degree and host relatively little riparian vegetation, although standing water and herbaceous and wetland vegetation may be present. The loss of flowing water would likely lead to complete loss of these pools and fringe vegetation.

ANTICIPATED IMPACTS ON QUEEN CREEK

Impact on the flowing reach of Queen Creek between Superior and Boyce Thompson Arboretum is not anticipated under the best-calibrated model run, and impact is anticipated under less than 5 percent of the sensitivity model runs (4 of 87 sensitivity runs suggest an impact). Impacts on groundwater inflow in this reach are considered possible, but unlikely.

Table 3.7.1-5. Summary of potential impacts on groundwater-dependent ecosystems from surface flow losses

Reference Number on Figure 3.7.1-7	GDE	Summary of Expected Impacts on GDEs
	Queen Creek and Tributaries	
Not numbered on figure	Queen Creek above Superior (from confluence with Oak Flat Wash [~km 26] to Magma Avenue Bridge [km 21.7], including springs QC23.6C [Boulder Hole], Queen Seeps, and QC22.6E [Karst Spring])	No Action – No reduction in runoff would occur from subsidence. Proposed Action – Reduction in surface runoff volume due to subsidence is estimated to be 18.6% at Magma Avenue Bridge (see Section 3.7.3, Surface Water Quantity). Reduction in runoff volume could reduce amount of water temporarily stored in shallow alluvium or fracture networks. Impacts above Superior could include a reduction or loss of spring/stream flow, increased mortality or reduction in extent or health of riparian vegetation, and reduction in the quality or quantity of aquatic habitat from loss of flowing water, adjacent vegetation, or standing pools.
Not numbered on figure	Queen Creek below Superior (from Magma Avenue Bridge [km 21.7] to Whitlow Ranch Dam [km 0])	No Action – No reduction in runoff would occur from subsidence or tailings alternatives. Proposed Action/Subsidence – Reduction in surface runoff volume due to subsidence is estimated to range from 13.4% reduction at Boyce Thompson Arboretum to 3.5% reduction at Whitlow Ranch Dam. Channel largely ephemeral and habitat is generally xeroriparian in nature, accustomed to ephemeral, periodic flows. Impacts on this type of vegetation would be unlikely due to surface flow reductions of this magnitude. Alternative 2 and 3 – The combined reduction in runoff volume from subsidence with a reduction in runoff volume due to a tailings storage facility at the Near West location (Alternative 2 or 3) is estimated as 6.5% at Whitlow Ranch Dam. Channel largely ephemeral and habitat is generally xeroriparian in nature, accustomed to ephemeral, periodic flows. Impacts on this type of vegetation would be unlikely due to surface flow reductions of this magnitude. Alternative 4 – The combined reduction in runoff volume from subsidence with a reduction in runoff volume due to a tailings storage facility at the Silver King location (Alternative 4) is estimated to range from a 19.9% reduction at Boyce Thompson Arboretum to an 8.9% reduction at Whitlow Ranch Dam. Reduction in runoff volume could reduce the amount of water temporarily stored in shallow alluvium or fracture networks. Impacts at Boyce Thompson Arboretum could include a reduction or loss of spring/stream flow, increased mortality or reduction in extent or health of riparian vegetation, and reduction in the quality or quantity of aquatic habitat from loss of flowing water, adjacent vegetation, or standing pools.
1	Whitlow Ranch Dam Outlet	No Action – Drawdown is not anticipated. Proposed Action – Additional drawdown due to block-caving is not anticipated, and reduction in surface runoff is anticipated 3.5%, but impacts on riparian vegetation are unlikely due to geological controls on groundwater levels. Location would be monitored during operations for verification of potential impacts.

continued

Table 3.7.1-5. Summary of potential impacts on groundwater-dependent ecosystems from surface flow losses *(cont'd)*

Reference Number on Figure 3.7.1-7	GDE	Summary of Expected Impacts on GDEs
15	Oak Flat Wash	No Action – No reduction in runoff would occur from subsidence. Proposed Action – A portion of the Oak Flat Wash watershed is within the subsidence area, and a reduction in surface water volume is anticipated. These impacts are already incorporated into the quantitative modeling for Queen Creek.
	Devil's Canyon and Tributaries	
16	Devil's Canyon (from km 9.3 to confluence with Mineral Creek [km 0]).	No Action – No reduction in runoff would occur from subsidence. Proposed Action – Reduction in surface runoff volume due to subsidence ranges from 5.6% reduction at DC8.1C to 3.5% reduction at confluence with Mineral Creek (see Section 3.7.3, Surface Water Quantity). During critical dry season (May/June), percent reductions are approximately the same. Flow reductions could contribute to a reduction in the extent and health of riparian vegetation and aquatic habitat. Complete drying of the downstream habitat, loss of dominant riparian vegetation, or loss of standing pools would be unlikely.
17	Rancho Rio Canyon (RR1.5C)	No Action – No reduction in runoff would occur from subsidence. Proposed Action – A portion of the Rancho Rio Canyon watershed is within the subsidence area, and a reduction in surface water volume is anticipated. These impacts are already incorporated into the quantitative modeling for Devil's Canyon.

This reach is believed to potentially have three sources of flow (Garrett 2018d):

- groundwater inflow into this reach is possible and assumed, but not certain;
- effluent from the Town of Superior Wastewater Treatment Plant occurs and is estimated at 170 acre-feet per year; and
- discharge of groundwater from a perlite mine pit southwest of Superior is estimated at 170 acre-feet per year.

Aside from groundwater drawdown, this reach of Queen Creek also would see reductions in runoff due to the subsidence area, ranging from about 19 percent in Superior to 13 percent at Boyce Thompson Arboretum (see table 3.7.1-5). The anticipated 13 to 19 percent loss in flow during the dry season could contribute to a reduction in the extent and health of riparian vegetation and aquatic habitat. The complete drying of the downstream habitat, loss of dominant riparian vegetation, or loss of standing pools would be unlikely.

Between Boyce Thompson and Whitlow Ranch Dam, Queen Creek is largely ephemeral, and habitat is generally xeroriparian in nature, accustomed to ephemeral, periodic flows. Impacts on this type of vegetation would be unlikely due to surface flow reductions. The riparian area along Queen Creek at Whitlow Ranch Dam would be impacted by reductions in surface flow of roughly 3.5 percent. The groundwater levels in this area are primarily controlled by the fact that this area represents the discharge point for the Superior basin and the influence of Whitlow Ranch Dam impounding flow. Given this control, a 3.5 percent change in surface flow would be unlikely to greatly affect groundwater levels at this location, nor does the groundwater flow model predict any drawdown at this distance from the mine. Impacts on the riparian area at Whitlow Ranch Dam would not be expected to be substantial.

The location on Queen Creek most at risk is likely above Superior, with possible surface flow losses of more than 19 percent. Reduction in runoff volume could reduce the amount of water temporarily stored in shallow alluvium or fracture networks. Impacts above Superior could include a reduction or loss of spring/stream flow, increased mortality or reduction in extent or health of riparian vegetation, and reduction in the quality or quantity of aquatic habitat from loss of flowing water, adjacent vegetation, or standing pools.

POTENTIAL IMPACT ON SURFACE WATER RIGHTS FROM GROUNDWATER DRAWDOWN

Arizona law allows for the right to appropriate and use surface water, generally based on a “first in time, first in right” basis. This function is administered by the ADWR, which maintains databases of water right filings, reviews applications and claims, and when appropriate issues permits and certificates of water right. However, water right filings can be made on the same surface water by multiple parties, and at this time almost all Arizona surface waters are over-appropriated with no clear prioritization of overlapping water rights. In addition, the State of Arizona has a bifurcated water rights system in which groundwater and surface water use are considered separately, and state law as of yet provides no clear framework for the interaction between groundwater and surface water uses.

To remedy these issues, a legal proceeding called the General Stream Adjudication of the Gila River is being undertaken through the Arizona court system. Goals of the adjudication include clarifying the validity and priority of surface water rights and providing a clear legal framework for when groundwater withdrawals would impinge on surface water rights. The adjudication has been underway for several decades, and while progress has been made, many issues remain unresolved, including any prioritization or validation of water rights in the analysis area.

Groundwater drawdown associated with the project is anticipated to impact eight GDEs. Known surface water filings associated with these GDEs are summarized in table 3.7.1-6. The Forest Service analysis identifies and discloses possible loss of water to these GDEs; however, the impact on any surface water rights from a legal or regulatory standpoint cannot yet be determined due to the ongoing adjudication.

Table 3.7.1-6. Summary of water right filings associated with GDEs impacted by groundwater drawdown

Specific GDE Potentially Impacted by Groundwater Drawdown	Arizona Water Right Filings
DC-6.6W Spring	Filing of Statement of Claim of Right to Use Public Waters of the State, 36-1757, filed 1986 by Arizona State Land Department
Bitter Spring	Filing of Statement of Claim of Right to Use Public Waters of the State, 36-24054, filed 1979 by Tonto National Forest
Bored Spring	Application for a Permit to Appropriate Public Waters of the State of Arizona #A-2014, filed 1938 by Crook National Forest Permit to Appropriate #A-1376, issued 1939 to Crook National Forest by State Water Commissioner Certificate of Water Right #955, issued 1941 to Crook National Forest by State Water Commissioner
Hidden Spring	Filing of Statement of Claim of Right to Use Public Waters of the State, 36-24052, filed 1979 by Tonto National Forest
Kane Spring	No filings identified
McGinnel Mine Spring	Application for a Permit to Appropriate Public Waters of the State of Arizona, 33-94335, filed 1988 by Tonto National Forest Proof of Appropriation of Water, 33-94335, filed 1989 by Tonto National Forest Permit to Appropriate Public Waters of the State of Arizona, 33-94335, issued 1989 by ADWR Certificate of Water Right 33-94355, issued 1990 by ADWR
McGinnel Spring	Statement of Claim of Right to Use Public Waters of the State, 36-24049, filed 1979 by Tonto National Forest
Walker Spring	No filings identified

ANTICIPATED IMPACTS ON WATER SUPPLY WELLS

Many domestic and stock water supply wells in the area are shallow and likely make use of water stored in shallow alluvium or shallow fracture networks. These wells are unlikely to be impacted by groundwater drawdown from the mine. However, groundwater drawdown caused by the mine could affect groundwater supplies for wells that may draw from either the regional Apache Leap Tuff aquifer or the deep groundwater system. Drawdown from 10 to 30 feet is anticipated in wells in the Superior area, as shown in table 3.7.1-4. In addition, in about 20 percent of sensitivity modeling runs, impacts from 10 to 30 feet could also occur in wells near Top-of-the-World.

The applicant-committed environmental protection measures include remedying any impacts on water supply wells caused by drawdown from the project.

LONGER TERM MODELED IMPACTS – SPRINGS IN THE QUEEN CREEK BASIN

Under the proposed action, drawdown continues to propagate well beyond 200 years. The modeled groundwater level trends generally suggest maximum drawdown does not occur until 600 to 800 years after the end of mining at the distant spring locations (Morey 2018c).

As described earlier in this section, eight of the springs (Bitter, Bored, Hidden, Kane, McGinnel, McGinnel Mine, Walker, and DC6.6W) see impacts great enough under either the no action alternative or proposed action to effectively dry the spring. The remaining springs without anticipated impacts (Iberri, No Name, and Rock Horizontal) may still experience drawdown beyond 200 years, but the magnitude and trends of drawdown observed are unlikely to change the anticipated impacts (see hydrographs in appendix L).

LONGER TERM MODELED IMPACTS – DEVIL’S CANYON

For most of Devil’s Canyon (including spring DC-6.6W), drawdown under the proposed action scenario reaches its maximum extent within

50 to 150 years after the end of mining; the impacts shown in table 3.7.1-3 likely represent the maximum impacts under the proposed action scenario.

LONGER TERM MODELED IMPACTS – QUEEN CREEK, TELEGRAPH CANYON, AND ARNETT CREEK

Predicted drawdown at Queen Creek, Telegraph Canyon, and Arnett Creek did not exceed the quantitative 10-foot drawdown threshold, except in a small number of sensitivity modeling runs. However, predicted groundwater level trends indicate that the maximum drawdown would not occur at these locations for roughly 500 to 900 years, suggesting impacts could be greater than those reported in table 3.7.1-3 (Morey 2018c).

For Telegraph Canyon and Arnett Creek, while drawdown may still be occurring beyond 200 years, the magnitude and trends of drawdown observed are unlikely to change the anticipated impacts (see hydrographs in appendix L).

For the flowing reach of Queen Creek below Superior, while the impacts predicted by the best-calibrated model did not exceed the quantitative threshold of 10 feet, trends of drawdown suggest this could occur after 200 years. With consideration to the uncertainties in the analysis, impacts on the groundwater-related flow components of Queen Creek appear to be possible to occur at some point.

LONGER TERM MODELED IMPACTS – WATER SUPPLIES

Potential impacts on groundwater supplies associated with the regional aquifer were already identified as possible for both Top-of-the-World and Superior. The predicted groundwater trends suggest that the impacts shown in table 3.7.1-4 for Top-of-the-World are likely the maximum impacts expected (Morey 2018c). However, the groundwater trends for wells in Superior (represented by well DHRES-16_753) suggest that maximum drawdown would not occur until roughly 600 years after the end of mining. Impacts on groundwater supplies relying on the regional deep groundwater system near Superior may continue to worsen beyond the results report in table 3.7.1-4.

POTENTIAL FOR LAND SUBSIDENCE DUE TO GROUNDWATER PUMPING

Two areas have the potential for land subsidence due to groundwater pumping: the area around the East Plant Site and mining panels where dewatering pumping would continue to occur, and the area around the Desert Wellfield. While small amounts of land subsidence attributable to the dewatering pumping have been observed around the East Plant Site using satellite techniques (approximately 1.5 inches, between 2011 and 2016), once mining operations begin, any land subsidence due to pumping would be subsumed by subsidence caused by the block-caving (estimated to be 800 feet deep, and possibly as deep as 1,100 feet at the end of mining).

Drawdown associated with the Desert Wellfield would contribute to lowering of groundwater levels in the East Salt River valley subbasin, including near two known areas of known ground subsidence. Further detailed analysis of land subsidence resulting from groundwater withdrawal is not feasible beyond noting the potential for any pumping to contribute to drawdown and subsidence. Subsidence effects are a basin-wide phenomenon, and the impact from one individual pumping source cannot be predicted or quantified.

Alternative 2 – Near West Proposed Action

GROUNDWATER-DEPENDENT ECOSYSTEMS IMPACTED

Three GDEs would be directly disturbed by a tailings facility at the Near West site: Bear Tank Canyon Spring, Benson Spring, and Perlite Spring. All three of these GDEs are believed to be disconnected from the regional aquifers, relying on precipitation stored in shallow alluvium or fracture networks. Benson Spring is located near the front of the facility, potentially under the tailings embankment. Bear Tank Canyon Spring

is located in the middle of the facility under the NPAG tailings, and Perlite Spring is located at the northern edge of the facility, near the PAG tailings cell.

In total, 16 GDEs are anticipated to be impacted under Alternative 2 (see figure 3.7.1-9):

- Six springs are anticipated to be impacted from continued dewatering under the no action alternative.
- Two additional springs are anticipated to be impacted under the proposed action, because of the block-cave mining.
- Two springs are directly disturbed by the subsidence area.
- Three springs are directly disturbed by the Alternative 2 tailings storage facility.
- One perennial stream (Devil's Canyon) is impacted by reduced runoff from the subsidence area.
- Two perennial stream reaches on Queen Creek are impacted by reduced runoff from both the subsidence area and the tailings.

CHANGES IN TAILINGS WATER BALANCE

The substantial differences in water balance between alternatives are directly related to the location and design of the tailings storage facility. There are five major differences, as shown in table 3.7.1-7:

- **Entrainment.** The tailings deposition method affects the amount of water that gets deposited and retained with the tailings. Alternative 2 entrains about the same amount of water as the other slurry tailings alternatives (Alternatives 3, 5, and 6), but substantially more than Alternative 4.
- **Evaporation.** The tailings deposition method also affects the amount of water lost through evaporation, even among slurry tailings. Alternative 2 evaporates a similar amount of water as Alternatives 5 and 6, but substantially more than Alternatives 3 and 4.
- **Watershed losses.** Watershed losses from the capture of precipitation depend primarily on the location of the tailings storage facility and where it sits in the watershed. Surface runoff losses are summarized in table 3.7.1-5, and are analyzed in greater detail in Section 3.7.3, Surface Water Quantity.
- **Seepage.** Differences in seepage losses are substantial between alternatives. Three estimates of seepage are shown in table 3.7.1-7. The amount of seepage based on the initial tailings designs using only the most basic level of seepage controls is shown, and primarily reflects the type of tailings deposition and geology (WestLand Resources Inc. 2018b). After these initial designs, the engineered seepage controls were refined as part of efforts to reduce impacts on water quality from the seepage (Klohn Crippen Berger Ltd. 2019d). The estimated reduced seepage rates with all engineered seepage controls in place, both during operations and post-closure, are also shown in table 3.7.1-7. Alternative 2 loses more seepage than Alternatives 3 and 4, but less seepage than Alternatives 5 and 6. The effects of seepage on groundwater and surface water quality are analyzed in greater detail in Section 3.7.2, Groundwater and Surface Water Quality.

CHANGES IN DESERT WELLFIELD PUMPING

The water balances for the alternatives are very complex, with multiple water sources and many recycling loops. However, ultimately a certain amount of makeup water is needed, which must be pumped from Desert Wellfield in the East Salt River valley. Alternative 2 requires the most makeup water, roughly 600,000 acre-feet over the life of the mine. The amount of groundwater in storage in the East Salt River valley subbasin (above a depth of 1,000 feet) is estimated to be about 8.1 million acre-feet. Pumping under Alternative 2 represents about 7.3 percent of the available groundwater in the East Salt River valley subbasin.

Table 3.7.1-7. Primary differences between alternative water balances

Alternative	Water Entrained with Tailings (acre-feet, life of mine)	Precipitation or Runoff Intercepted (acre-feet, life of mine)*	Percentage Loss to Downstream Waters†	Water Lost to Evaporation from Tailings Storage Facility (acre-feet, life of mine)*	Water Lost as Seepage from Tailings Storage Facility without Engineered Seepage Controls (acre-feet, life of mine)	Water Lost as Seepage to Aquifer after Engineered Seepage Controls during Operations (acre-feet, life of mine)	Water Lost as Seepage to Aquifer, Post-Closure (acre-feet per year)	Makeup Water Pumped from Desert Wellfield (acre-feet, life of mine)
2	271,839	68,780	6.5	307,903	5,741	849	20.7	586,508
3	305,443	60,531	6.5	174,742	2,891	111	2.7	494,286
4	71,017	110,854	8.9	135,102	3,148	369–680	15.2–31.9	175,800
5	308,404	278,639	0.2	384,702	53,184	10,701	261	544,778
6	277,710	205,297	0.3	384,427	17,940	2,665–7,298	202–258	544,858

Source: Ritter (2018). For seepage losses after engineered seepage controls, during operations and post-closure, see Klohn Crippen Berger Ltd. (2019d) and Gregory and Bayley (2019)

* Alternatives 5 and 6 include total precipitation on and evaporation from the tailings beach. However, precipitation onto the tailings beach that evaporates before contributing to the mine water balance is not included in the estimated precipitation and evaporation volumes for Alternatives 2, 3, and 4. These different accounting methods for evaporation and precipitation do not impact the total makeup water demand estimates for the Desert Wellfield

† Alternatives 2, 3, and 4 reflect change in percentage of annual flow in Queen Creek at Whitlow Ranch Dam. Alternatives 5 and 6 reflect change in percentage of annual flow in the Gila River at Donnelly Wash. These numbers only account for precipitation captured by tailings facilities or subsidence area. Water rerouted around the facilities or seepage reappearing downstream is not incorporated.

Projected drawdown would be greatest in the center of the Desert Wellfield, reaching a maximum drawdown of 228 feet, as shown in figure 3.7.1-2. These groundwater levels recover after mining ceases, eventually recovering to less than 20 feet. Drawdown decreases with distance from the wellfield. At the north and south ends of the wellfield, maximum drawdown ranges from 109 to 132 feet, and farther south within NMIDD, maximum drawdown is roughly 49 feet (Bates et al. 2018; Garrett 2018a).

Alternative 3 – near west – Ultrathickened

GROUNDWATER-DEPENDENT ECOSYSTEMS IMPACTED

The GDEs impacted are identical to those impacted under Alternative 2.

CHANGES IN TAILINGS WATER BALANCE

The following water balance components for Alternative 3 are summarized in table 3.7.1-7:

- **Entrainment.** Alternative 3 entrains about the same amount of water as the other slurry tailings alternatives (Alternatives 3, 5, and 6), but substantially more than Alternative 4.
- **Evaporation.** Alternative 3 evaporates less water than Alternatives 2, 5, and 6, and almost matches the filtered tailings alternative (Alternative 4) for reductions in evaporation.
- **Watershed losses.** Watershed losses are the same as Alternative 2.
- **Seepage.** With engineered seepage controls in place, Alternative 3 loses the least amount of seepage of any alternative, including the filtered tailings alternative (Alternative 4).

CHANGES IN DESERT WELLFIELD PUMPING

Alternative 3 requires less makeup water than Alternative 2, roughly 500,000 acre-feet over the life of the mine. Pumping under Alternative 3 represents about 6.1 percent of the estimated 8.1 million acre-feet of available groundwater in the East Salt River valley subbasin (Garrett 2018a).

Maximum drawdown for Alternative 3 reaches about 177 feet, eventually recovering to less than 20 feet. At the north and south ends of the wellfield, maximum drawdown ranges from 87 to 105 feet, and farther south within NMIDD maximum drawdown is roughly 42 feet (Bates et al. 2018; Garrett 2018a).

Alternative 4 – Silver King

GROUNDWATER-DEPENDENT ECOSYSTEMS IMPACTED

Two GDEs would be directly disturbed by a tailings facility at the Silver King site: Iberri Spring and McGinnel Spring. Both of these springs are assumed to be at least partially connected to the regional aquifers; both are located under the NPAG tailings facility.

In total, 14 GDEs are anticipated to be impacted under Alternative 4 (see figure 3.7.1-9):

- Six springs are anticipated to be impacted from continued dewatering under the no action alternative.
- Two additional springs are anticipated to be impacted under the proposed action, because of the block-cave mining.
- Two springs are directly disturbed by the subsidence area.
- Two springs are directly disturbed by the Alternative 4 tailings storage facility; however, one of these was already impacted under the no action alternative.

- One perennial stream (Devil's Canyon) is impacted by reduced runoff from the subsidence area.
- Two perennial stream reaches on Queen Creek are impacted by reduced runoff from both the subsidence area and the tailings.

For the other action alternatives, there was an anticipated 7 to 15 percent loss in flow in Queen Creek below Superior to Boyce Thompson Arboretum. Because of the location of Alternative 4 at the head of the watershed, these flow losses are more substantial, ranging from 7 percent in Superior, to 20 percent at Boyce Thompson Arboretum, to 9 percent at Whitlow Ranch Dam. Reduction in runoff volume could reduce the amount of water temporarily stored in shallow alluvium or fracture networks.

Impacts at Boyce Thompson Arboretum could include a reduction or loss of spring/stream flow, increased mortality or reduction in extent or health of riparian vegetation, and reduction in the quality or quantity of aquatic habitat from loss of flowing water, adjacent vegetation, or standing pools. Substantial impacts on the riparian vegetation at Whitlow Ranch Dam are still unlikely due to the geological controls, although the reductions in runoff are greater under Alternative 4 than other alternatives.

CHANGES IN TAILINGS WATER BALANCE

The following water balance components for Alternative 4 are summarized in table 3.7.1-7:

- **Entrainment**. Because water is filtered from the tailings before placement, Alternative 4 entrains the least amount of water of all alternatives, approximately only one-quarter of that entrained under Alternative 2.
- **Evaporation**. Because Alternative 4 does not have a standing recycled water pond, Alternative 4 also evaporates the least amount of water of all alternatives, approximately only one-half of that of Alternative 2.
- **Watershed losses**. Watershed losses are higher than Alternatives 2 and 3, due to the position of Alternative 4 higher in the Queen Creek watershed, and the need for stringent stormwater control to avoid contact of water with exposed PAG tailings.
- **Seepage**. Alternative 4 loses the least amount of seepage of all alternatives, except for Alternative 3 (ultrathickened).

CHANGES IN DESERT WELLFIELD PUMPING

Alternative 4 requires the least amount of makeup water of all alternatives, roughly 180,000 acre-feet over the life of the mine, or roughly 30 percent of the makeup water required for the slurry tailings alternatives (Alternatives 2, 3, 5, and 6). Pumping under Alternative 4 represents about 2.2 percent of the estimated 8.1 million acre-feet of available groundwater in the East Salt River valley subbasin (Garrett 2018a).

Alternative 4 also results in the least amount of drawdown, as shown in figure 3.7.1-2. Maximum drawdown for Alternative 4 reaches about 53 feet, eventually recovering to roughly 5 feet. At the north and south ends of the wellfield, maximum drawdown ranges from 30 to 35 feet, and farther south within NMIDD maximum drawdown is roughly 17 feet (Bates et al. 2018; Garrett 2018a).

Alternative 5 – Peg Leg

GROUNDWATER-DEPENDENT ECOSYSTEMS IMPACTED

No GDEs have been identified within the vicinity of the Peg Leg site or are expected to be directly disturbed. In total, 14 GDEs are anticipated to be impacted under Alternative 5 (see figure 3.7.1-9):

- Six springs are anticipated to be impacted from continued dewatering under the no action alternative.

- Two additional springs are anticipated to be impacted under the proposed action because of the block-cave mining.
- Two springs are directly disturbed by the subsidence area.
- Three perennial stream reaches in Devil's Canyon and Queen Creek are impacted by reduced runoff from the subsidence area.
- One perennial stream reach of the Gila River is impacted by reduced runoff from the tailings facility.

CHANGES IN TAILINGS WATER BALANCE

The following water balance components for Alternative 5 are summarized in table 3.7.1-7:

- **Entrainment.** Alternative 5 entrains about the same amount of water as the other slurry tailings alternatives (Alternatives 2, 5, and 6), but substantially more than Alternative 4.
- **Evaporation.** Alternative 5 loses the most amount of water to evaporation of all alternatives, about 25 percent more than Alternative 2.
- **Watershed losses.** Watershed losses (as a percentage change in perennial flow) are relatively low for Alternative 5, largely due to the large watershed and flow of the Gila River.
- **Seepage.** Because of the location over a deep alluvial basin, Alternative 5 loses substantially more seepage than all other alternatives.

CHANGES IN DESERT WELLFIELD PUMPING

Alternative 5 requires more water to move the tailings slurry over long distances, and to make up for seepage losses. Alternative 5 uses only slightly less water than Alternative 2, about 550,000 acre-feet over the life of the mine. Pumping under Alternative 5 represents about 6.7 percent of the estimated 8.1 million acre-feet of available groundwater in the East Salt River valley subbasin (Garrett 2018a).

Maximum drawdown for Alternative 5 reaches about 199 feet, eventually recovering to less than 20 feet. At the north and south ends of the wellfield, maximum drawdown ranges from 96 to 115 feet, and farther south within NMIDD maximum drawdown is roughly 46 feet (Bates et al. 2018; Garrett 2018a).

Alternative 6 – Skunk Camp

GROUNDWATER-DEPENDENT ECOSYSTEMS IMPACTED

No GDEs have been identified within the vicinity of the Skunk Camp site based on site-specific information. In total, 14 GDEs are anticipated to be impacted under Alternative 6, the same as under Alternative 5 (see figure 3.7.1-9):

- Six springs are anticipated to be impacted from continued dewatering under the no action alternative.
- Two additional springs are anticipated to be impacted under the proposed action, because of the block-cave mining.
- Two springs are directly disturbed by the subsidence area.
- Three perennial stream reaches in Devil's Canyon and Queen Creek are impacted by reduced runoff from the subsidence area.
- One perennial stream reach of the Gila River is impacted by reduced runoff from the tailings facility.

CHANGES IN TAILINGS WATER BALANCE

The following water balance components for Alternative 6 are summarized in table 3.7.1-6:

- **Entrainment.** Alternative 6 entrains about the same amount of water as the other slurry tailings alternatives (Alternatives 2, 5, and 6), but substantially more than Alternative 4.

- **Evaporation.** Alternative 6 loses almost as much water to evaporation as the alternative with the greatest evaporative losses (Alternative 5), about 25 percent more than Alternative 2.
- **Watershed losses.** Watershed losses (as a percentage change in perennial flow) are relatively low for Alternative 6, largely due to the large watershed and flow of the Gila River.
- **Seepage.** Because of the location over an alluvial basin, Alternative 6 loses substantially more than Alternatives 2, 3, and 4, but still less than Alternative 5.

CHANGES IN DESERT WELLFIELD PUMPING

Alternative 6 requires more water to move the tailings slurry over long distances, and to make up for seepage losses. Alternative 6 uses only slightly less water than Alternative 2, about 550,000 acre-feet over the life of the mine, and about the same as Alternative 5. Pumping under Alternative 6 represents about 6.7 percent of the estimated 8.1 million acre-feet of available groundwater in the East Salt River valley subbasin (Garrett 2018a).

Drawdown from Alternative 6 is nearly identical to that of Alternative 5.

Cumulative Effects

The Tonto National Forest identified the following reasonably foreseeable future actions as likely, in conjunction with development of the Resolution Copper Mine, to contribute to cumulative impacts on groundwater quantity and GDEs. As noted in section 3.1, past and present actions are assessed as part of the affected environment; this section analyzes the effects of any RFFAs, to be considered cumulatively along with the affected environment and Resolution Copper Project effects.

- *Ripsey Wash Tailings Project.* Mining company ASARCO is planning to construct a new tailings storage facility to support its Ray Mine operations. The environmental effects of the project were analyzed in an EIS conducted by the USACE and approved in a ROD issued in December 2018. As approved, the proposed tailings storage facility project would occupy an estimated 2,574 acres and would be situated in the Ripsey Wash watershed just south of the Gila River approximately 5 miles west-northwest of Kearny, Arizona, and would contain up to approximately 750 million tons of material (tailings and embankment material). ASARCO estimates a construction period of 3 years and approximately 50 years of expansion of the footprint of the tailings storage facility as slurry tailings are added to the facility, followed by a 7- to 10-year period for reclamation and final closure. This project is estimated to result in a reduction of recharge to the Gila River of 0.2 percent. This would be cumulative with losses from either Alternative 5 (estimated reduction in flow in the Gila River at Donnelly Wash of 0.2 percent) or Alternative 6 (estimated reduction in flow in the Gila River at Donnelly Wash of 0.3 percent).
- *LEN Range Improvements.* This range allotment is located near Ray Mine. Under the proposed action, upland perennial sources of water would be provided to supplement the existing upland water infrastructure on the allotment. The supplemental water sources would provide adequate water facilities for existing authorized grazing management activities. While beneficial, these water sources are located in a different geographic area than the GDEs potentially impacted by the Resolution Copper Project.
- *Millsite Range Improvements*. This range allotment is located 20 miles east of Apache Junction, on the southern end of the Mesa Ranger District. The Mesa Ranger District is proposing to add three new 10,000-gallon storage tanks and two 600-gallon troughs to improve range condition through better livestock distribution and to provide additional wildlife waters in three pastures on the allotment. Water developments are proposed within the Cottonwood, Bear Tanks, and Hewitt pastures of the Millsite grazing allotment. These improvements would be beneficial for providing water on the landscape and are within

the same geographic area where some water sources could be lost (Alternatives 2 and 3); they may offset some loss of water that would result because of the Resolution Copper Project tailings storage facility construction.

- *Ray Land Exchange and Proposed Plan Amendment.* ASARCO is also seeking to complete a land exchange with the BLM by which the mining company would gain title to approximately 10,976 acres of public lands and federally owned mineral estate located near ASARCO's Ray Mine in exchange for transferring to the BLM approximately 7,304 acres of private lands, primarily in northwestern Arizona. It is known that at some point ASARCO wishes to develop a copper mining operation in the "Copper Butte" area west of the Ray Mine; however, no details are currently available as to potential environmental effects, including to groundwater quantity and GDEs, resulting from this possible future mining operation. Given the location of this activity, impacts on water could potentially be cumulative with Resolution Copper Project–related impacts on the Gila River for Alternatives 5 and 6.
- *Imerys Perlite Mine*. Imerys Perlite Mine submitted a plan of operations in 2013 which included plans for continued operation of the existing sedimentation basin at the millsite; continued use of segments of NFS Roads 229, 989, and 2403 for hauling; and mining at the Forgotten Wedge and Rosemarie Exception No. 8 claims. Dewatering is necessary to access the ore body in the active mine pit. This groundwater withdrawal would potentially be cumulative with dewatering impacts from the Resolution Copper Project.

Other projects and plans are certain to occur or be in place during the foreseeable life of the Resolution Copper Mine (50–55 years). These, combined with general population increase and ground-disturbing activities, may cumulatively contribute to future changes to groundwater supplies and GDEs.

EAST SALT RIVER VALLEY WATER SUPPLIES

Several reasonably foreseeable future actions were identified during the NEPA process but were determined too speculative to analyze for cumulative effects without detailed plans. These include potential housing developments in the town of Florence, and the ASLD's planned Superstition Vistas development area. A number of approved, assured water supplies were also identified in the East Salt River valley, and these describe future use of water in enough detail to be considered for cumulative effects. All of these potential future actions have the potential to be cumulative in combination with the impacts from the Desert Wellfield, resulting in greater drawdown than projected from the Resolution Copper Project.

RECHARGE AND RECOVERY CREDITS

Arizona water law allows for renewable sources of water to be recharged and stored in aquifers. Ultimately, this water can be recovered for use without needing a groundwater right (minus a 5 percent reduction to improve aquifer conditions).

Resolution Copper has been acquiring storage credits that would offset its future pumping, using various mechanisms. This was identified earlier in this section as an applicant-committed environmental protection measure (to offset approximately half the water supply). However, it is important to note that recharging water and acquiring storage credits is not required under Arizona water law; this is a voluntary measure by Resolution Copper. As such, while Resolution Copper has indicated its intent to do so, there is no guarantee that these credits would be used to offset the mine water supply, nor is there any requirement for the entire water supply to be offset by recharge credits.

- Between 2006 and 2011, Resolution Copper arranged for delivery of about 190,000 acre-feet of CAP water to NMIDD. NMIDD has been permitted as a "groundwater savings facility" through ADWR. At a groundwater savings facility, farmers forgo legal groundwater pumping (allowed with irrigation groundwater rights) and use renewable surface water on crops

instead. This mechanism allows groundwater to stay in the aquifer within the same basin from which the Desert Wellfield would eventually withdraw groundwater. Resolution Copper undertook similar measures for Roosevelt Water Conservation District (located in the East Salt River valley, west of the Desert Wellfield) for an additional 14,000 acre-feet of water.

- Resolution Copper has also physically recharged about 20,000 acre-feet of water at the Tonopah Desert Recharge Project; this facility is located west of the Phoenix metropolitan area and not in the same aquifer, but within the Phoenix AMA.
- Between 2012 and 2017, Resolution Copper also purchased an existing 37,000 acre-feet of storage credits, also stored at the NMIDD groundwater savings facility.
- Resolution Copper also has stored about 60,000 acre-feet water in the Pinal AMA, at the Hohokam Irrigation Drainage District groundwater savings facility.
- Resolution Copper continues to deliver treated water from mine infrastructure dewatering to NMIDD. However, because this amounts to a transfer of groundwater within an AMA, no storage credits are obtained in this manner.

All told, Resolution Copper has acquired 256,355 acre-feet of storage credits within the Phoenix AMA, and 313,135 acre-feet of storage credits between both the Phoenix and Pinal AMAs. This offsets roughly 43 to 52 percent of expected pumping for the slurry alternatives (Alternatives 2, 3, 5, and 6) and 143 percent of pumping for Alternative 4.

The impacts from the Desert Wellfield that are described in this section are based on the physical removal of water from the aquifer as it exists today and are not a reflection of the legal availability of that groundwater. Part of the groundwater physically stored in the aquifer is already legally attributable to other long-term storage credit holders; removal of this groundwater in the future would have a cumulative impact with the pumping from the Desert Wellfield.

REGIONAL WATER SUPPLIES

The area analyzed for assured water supplies incorporates Pinal County south of U.S. 60 through the town of Florence. A total of 239 entities presently hold assured water supply analyses or certificates, accounting for over 100,000 lots, and with a total 100-year groundwater demand of 11.1 million acre-feet. Not all of these entities are going to be drawing water from the same aquifer as the Desert Wellfield, nor would all this pumping happen during the mine life, nor does this list include any water use for anticipated development in the Superstitions Vistas planning area. Considering these uncertainties, it is not possible to quantify the cumulative water use in the area, but it is reasonable to note that groundwater demand is substantial and growing.

Resolution Copper's pumping from the Desert Wellfield represents the use of approximately 2.2 to 7.3 percent of the 8.1 million acre-feet estimated to be physically available in the aquifer (above a depth of 1,000 feet). Cumulatively, the total demand on the groundwater resources in the East Salt River valley is substantial and could be greater than the estimated amount of physically available groundwater.

Mitigation Effectiveness

The Forest Service is in the process of developing a robust mitigation plan to avoid, minimize, rectify, reduce, or compensate for resource impacts that have been identified during the process of preparing this EIS. Appendix J contains descriptions of mitigation concepts being considered and known to be effective, as of publication of the DEIS. Appendix J also contains descriptions of monitoring that would be needed to identify potential impacts and mitigation effectiveness. As noted in chapter 2 (section 2.3), the full suite of mitigation would be contained in the FEIS, required by the ROD, and ultimately included in the final GPO approved by the Forest Service. Public comment on the DEIS, and in particular appendix J, will inform the final suite of mitigations.

This section contains an assessment of the effectiveness of mitigation and monitoring measures found in appendix J that are applicable to groundwater quantity and GDEs.

MITIGATION MEASURES APPLICABLE TO GROUNDWATER QUANTITY AND GDES

Seeps and springs monitoring and mitigation plan (RC-211): One mitigation measure is contained in appendix J that would be applicable to groundwater quantity and GDEs. In April 2019, the Forest Service received from Resolution Copper a document titled "Monitoring and Mitigation Plan for Groundwater Dependent Ecosystems and Water Wells" (Montgomery and Associates Inc. 2019). This document outlines monitoring plan to assess potential impacts on each GDE, identifies triggers and associated actions to be taken by Resolution Copper to ensure that GDEs are preserved, and suggested mitigation measures for each GDE if it is shown to be impacted by future mine dewatering. Note that this plan includes actions both for GDEs and water supply wells.

The plan focuses on the same GDEs described in this section of the EIS, as these are the GDEs that are believed to rely on regional groundwater that could be impacted by the mine. The stated goal of the plan is "to ensure that groundwater supported flow that is lost due to mining activity is replaced and continues to be available to the ecosystem." The plan specifically notes that it is not intended to address water sources associated with perched shallow groundwater in alluvium or fractures.

The specific GDEs addressed by this plan include

- Bitter, Bored, Hidden, Iberri, Kane, McGinnel, McGinnel Mine, No Name, Rock Horizontal, and Walker Springs;
- Queen Creek below Superior (reach km 17.39 to 15.55) and at Whitlow Ranch Dam;
- Arnett Creek in two locations;
- Telegraph Canyon in two locations;
- Devil's Canyon springs (DC4.1E, DC6.1E, DC6.6W, and DC8.2W)
- Devil's Canyon surface water in two locations (reach km 9.1 to 7.5, and reach km 6.1 to 5.4)
- Mineral Creek springs (Government Springs, MC3.4W)
- Mineral Creek surface water in two locations (MC8.4C, and reach km 6.9 to 1.6)

Monitoring frequency and parameters are discussed in the plan, and include such things as groundwater level or pressure, surface water level, presence of water or flow, extent of saturated reach, and phreatophyte area. In general, groundwater level or pressure and surface water level would be monitored daily (using automated equipment), while other methods would be monitored quarterly or annually.

Water supplies to be monitored are Superior (using well DHRES-16_743 as a proxy), Boyce Thompson Arboretum (using the Gallery Well as a proxy), and Top-of-the-World (using HRES-06 as a proxy).

A variety of potential actions are identified that could be used to replace water sources if monitoring reaches a specified trigger. Specific details (likely sources and pipeline corridor routes) are shown in the plan. These include the following:

- Drilling new wells, applicable to both water supplies and GDEs. The intent of installing a well for a GDE is to pump supplemental groundwater that can be used to augment flow. The exact location and construction of the well would vary; it is assumed in many cases groundwater would be transported to GDEs via an overland pipeline to minimize ground disturbance. Wells require maintenance in perpetuity, and likely would be equipped with storage tanks and solar panels, depending on specific site needs.
- Installing spring boxes. These are structures installed into a slope at the discharge point of an existing spring, designed to capture natural flow. The natural flow is stored in a box and

discharged through a pipe. Spring boxes can be deepened to maintain access to water if the water level decreases. Spring boxes require little ongoing maintenance to operate.

- Installing guzzlers. Guzzlers are systems for harvesting rainwater for wildlife consumption. Guzzlers use an impermeable apron, typically installed on a slope, to collect rainwater which is then piped to a storage tank. A drinker allows wildlife and/or livestock to access water without trampling or further degrading the spring or water feature. Guzzlers require little ongoing maintenance to operate.
- Installing surface water capture systems such as check dams, alluvial capture, recharge wells, or surface water diversions. All of these can be used to supplement diminished groundwater flow at GDEs by retaining precipitation in the form of runoff or snowmelt, making it available for ecosystem requirements.
- Providing alternative water supplies from a non-local source. This would be considered only if no other water supply is available, with Arizona Water Company or the Desert Wellfield being likely sources of water.

MITIGATION EFFECTIVENESS AND IMPACTS

Effectiveness of Monitoring

The monitoring as proposed is of sufficient frequency and includes the necessary parameters to not only identify whether changes in GDEs are taking place, but also to inform whether the mine drawdown is responsible. For instance, conducting daily automated monitoring allows for an understanding of normal seasonal and drought-related fluctuations in water level or flow, which can be taken into consideration when evaluating the possible effects from the mine.

Effectiveness of Mitigation

Replacement of water sources using the techniques described (replacement wells or alternative water sources) would be highly effective for public water supplies. For GDEs, the effectiveness would depend on the specific approach. Engineered replacements like pipelines, guzzlers, or spring boxes would be effective at maintaining a water source and maintaining a riparian ecosystem, but the exact type, location, and extent of riparian vegetation could change to adapt to the new discharge location and frequency of the new water source. Changes in water quality are unlikely to be an issue, since new water sources would likely derive from the same source as natural spring flow (i.e., the Apache Leap Tuff aquifer, or stored precipitation).

While water flow, riparian ecosystems, and associated terrestrial and aquatic habitat would be maintained, there would still likely be a noticeable change in the overall environment that could affect both wildlife, recreationists, and the public. The presence of infrastructure like wells and pipes near some natural areas could change the sense of place and nature experienced in these locations.

Impacts from Mitigation Actions

The mitigation actions identified would result in additional ground disturbance, though minimal. Mitigation for any given GDE would likely result in less than 1 acre of impact, assuming a well pad and pipeline installation, or installation of check dams. If all mitigations were installed as indicated in the plan, impacts could total 20 to 30 acres of additional ground disturbance.

UNAVOIDABLE ADVERSE IMPACTS

Given the effectiveness of mitigation, there would be no residual impacts on public water supplies near the mine site. All lost water supplies would be replaced.

For GDEs expected to be impacted by groundwater drawdown, the mitigation measures described would be effective enough that there would be no net loss of riparian ecosystems or aquatic habitat on the landscape, although the exact nature and type of ecosystems would change to adapt to new water sources. However, impacts on the sense of

place and nature experienced at these perennial streams and springs, rare in a desert environment, would not be mitigated by these actions.

The mitigation plan would not mitigate any GDEs lost directly to surface disturbance, ranging from two to five, depending on the tailings alternative.

Impacts on water supplies in the East Salt River valley in the form of groundwater drawdown and reduction of regional groundwater supply would not be fully mitigated.

Other Required Disclosures

SHORT-TERM USES AND LONG-TERM PRODUCTIVITY

Groundwater pumping would last the duration of the mine life. At the mine itself, groundwater levels would slowly equilibrate over a long period (centuries). Groundwater drawdown from dewatering of the underground mine workings would constitute a permanent reduction in the productivity of groundwater resources within the long time frame expected for equilibrium. Groundwater in the vicinity of the Desert Wellfield would equilibrate more quickly, but there would still be an overall decline in the regional water table due to the Resolution Copper Project and a permanent loss of productivity of groundwater resources in the area.

Seeps and springs could be permanently impacted by drawdown in groundwater levels, as could the riparian areas associated with springs, but these impacts would be mitigated. GDEs or riparian areas directly lost to surface disturbance would be a permanent impact.

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

Mine dewatering at the East Plant Site under all action alternatives would result in the same irretrievable commitment of 160,000 acre-feet of water from the combined deep groundwater system and Apache Leap Tuff aquifer over the life of the mine.

Changes in total groundwater commitments at the Desert Wellfield vary by alternative for tailings locations and tailings type. Alternative 4 would require substantially less water overall than the other alternatives (176,000 acre-feet, vs. 586,000 acre-feet for Alternative 2). Loss of this water from the East Salt River valley aquifer is an irretrievable impact; the use of this water would be lost during the life of the mine.

While a number of GDEs and riparian areas could be impacted by groundwater drawdown, these changes are neither irreversible nor irretrievable, as mitigation would replace water sources as monitoring identifies problems. However, even if the water sources are replaced, the impact on the sense of nature and place for these natural riparian systems would be irreversible. In addition, the GDEs directly disturbed by the subsidence area or tailings alternatives represent irreversible impacts.

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Resolution Copper Project and Land Exchange

Draft

Environmental Impact Statement

Pinal County, Arizona
August 2019

Lead Agency:	**USDA Forest Service**
Cooperating Agencies:	**Arizona Department of Environmental Quality, Arizona Department of Water Resources, Arizona Game and Fish Department, Arizona State Land Department, Arizona State Mine Inspector, Bureau of Land Management, Pinal County Air Quality Control District, U.S. Army Corps of Engineers, U.S. Environmental Protection Agency**
Responsible Official:	**Neil Bosworth, Forest Supervisor** **2324 East McDowell Road, Phoenix, AZ 85006**
For Information, Contact:	**John Scaggs, Public Affairs Specialist** **2324 East McDowell Road, Phoenix, AZ 85006**

ABSTRACT: The purpose of and need for the environmental impact statement includes evaluating the impacts associated with approval of a mine plan, and considering the effects of the exchange of lands between Resolution Copper Mining, LLC, and the United States as directed by Section 3003 of the Carl Levin and Howard P. 'Buck' McKeon National Defense Authorization Act for Fiscal Year 2015 (NDAA).

The analysis includes six alternatives: the proposed action, which calls for a new underground mine underneath Oak Flat east of Superior, Arizona, and a tailings storage facility on National Forest System (NFS) lands west of Superior; a no action alternative under which neither the land exchange nor the mine plan would be authorized; an alternative that would allow a modified tailings disposal method at the same Near West tailings storage location as proposed; an alternative that would allow filtered tailings to be stored at another location on NFS lands north of Superior; and two alternatives that would not allow tailings to be stored on NFS lands, but on other agency or private lands. The scoping process identified water quantity, water quality, public health and safety, cultural resources, tribal concerns, and recreation as significant issues.

It is important that reviewers provide their comments at such times and in such a way that they are useful to the Agency's preparation of the EIS. Therefore, comments should be provided prior to the close of the comment period and should clearly articulate the reviewer's concerns and contentions. The submission of timely and specific comments can affect a reviewer's ability to participate in subsequent administrative review or judicial review. Comments received in response to this solicitation, including names and addresses of those who comment, will be part of the public record for this proposed action. Comments submitted anonymously will be accepted and considered; however, anonymous comments will not provide the respondent with standing to participate in subsequent administrative or judicial reviews.

Send Comments To:	**Resolution Copper EIS** **P.O. Box 34468** **Phoenix, AZ 85067-4468**
Date Comments Must Be Received:	**November 7, 2019**

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3.7.2 Groundwater and Surface Water Quality

3.7.2.1 Introduction

The proposed mine could potentially impact groundwater and surface water quality in several ways. The exposure of the mined rock to water and oxygen, inside the mine as well as in stockpiles prior to processing, can create depressed pH levels and high concentrations of dissolved metals, sulfate, and dissolved solids. After processing, the tailings would be transported for disposal into the tailings storage facility. Seepage from the tailings has the potential to enter underlying aquifers and impact groundwater quality. In addition, contact of surface runoff with mined ore, tailings, or processing areas has the potential to impact surface water quality.

This section contains analysis of existing groundwater and surface water quality; results of a suite of geochemical tests on mine rock; predicted water quality in the block-cave zone and potential exposure pathways, including the potential for a lake to form in the subsidence crater; impacts on groundwater and surface water from tailings seepage; impacts on surface water from runoff exposed to tailings; impacts on assimilative capacity of perennial waters; impacts on impaired waters; whether chemicals added during processing would persist in the tailings storage facility; the potential for asbestiform minerals to be present; and the potential for naturally occurring radioactive materials to be present. Some additional details not discussed in detail here are captured in the project record (Newell and Garrett 2018d).

3.7.2.2 Analysis Methodology, Assumptions, and Uncertain and Unknown Information

Analysis Area

The analysis area is shown in figure 3.7.2-1 and encompasses all areas where groundwater or surface water quality changes could potentially occur due to the proposed project and alternatives. This includes the block-cave zone, each alternatives tailings footprint, aquifers downgradient from each tailings facility, and downstream surface waters. The downstream limit of the analysis area is the location of the first perennial water, specifically Queen Creek at Whitlow Ranch Dam and the Gila River either at Donnelly Wash or Dripping Spring Wash. The goal of this section is to identify potential risks to water quality, including surface water. These perennial surface water locations are the point at which seepage would enter the surface water system and represent the location at which surface water quality is most at risk and any impacts on surface water or aquatic habitat would be greatest.

Geochemistry Modeling Process

All tailings storage facilities—including filtered tailings—lose water to the environment in the form of seepage that drains by gravity over time. This seepage into groundwater is the primary source of potential water contamination from the project and has the potential to affect the quality of underlying aquifers as well as downstream surface waters fed by those aquifers. The water quality of tailings seepage reflects a mixture of different water sources used in the mining process (see figure 2.2.2-16) as well as geochemical changes that occur over time within the tailings storage facility and changes that occur as seepage moves downgradient through the aquifer.

Modeling the water quality changes caused by seepage from the tailings storage facility[39] requires a series of interconnected analyses, as shown on figure 3.7.2-2. These analyses include the following:

- The amount of water that must be removed from the block-cave zone during operations to allow mining. This is estimated using the **groundwater flow model** discussed in detail in section 3.7.1.
- The geochemical changes of the groundwater within the underground block-cave zone caused by the interaction of

39. For details of the geochemistry modeling workgroup formed to direct and review the water quality modeling, see Newell and Garrett (2018d).

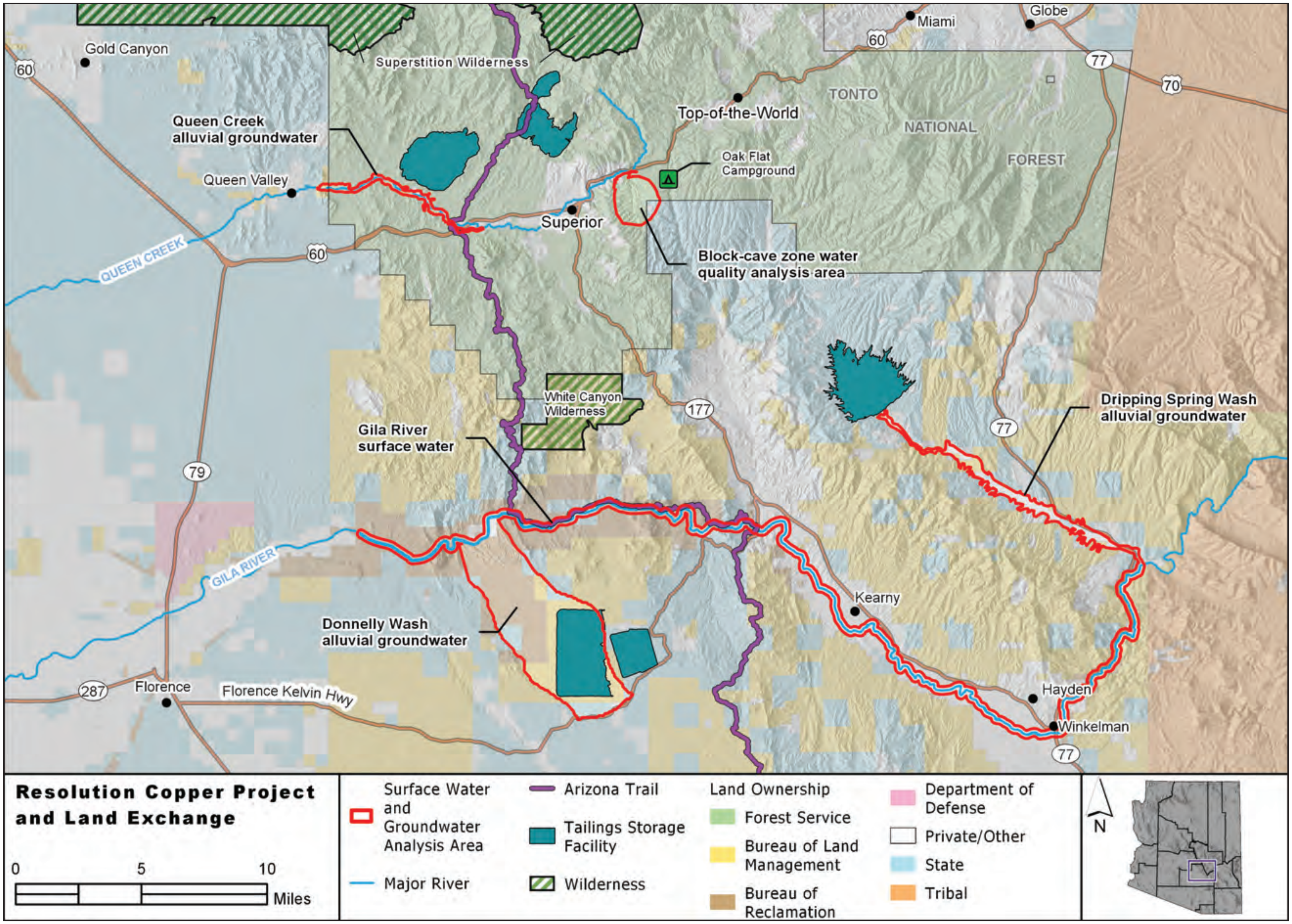


Figure 3.7.2-1. Analysis area for groundwater and surface water quality

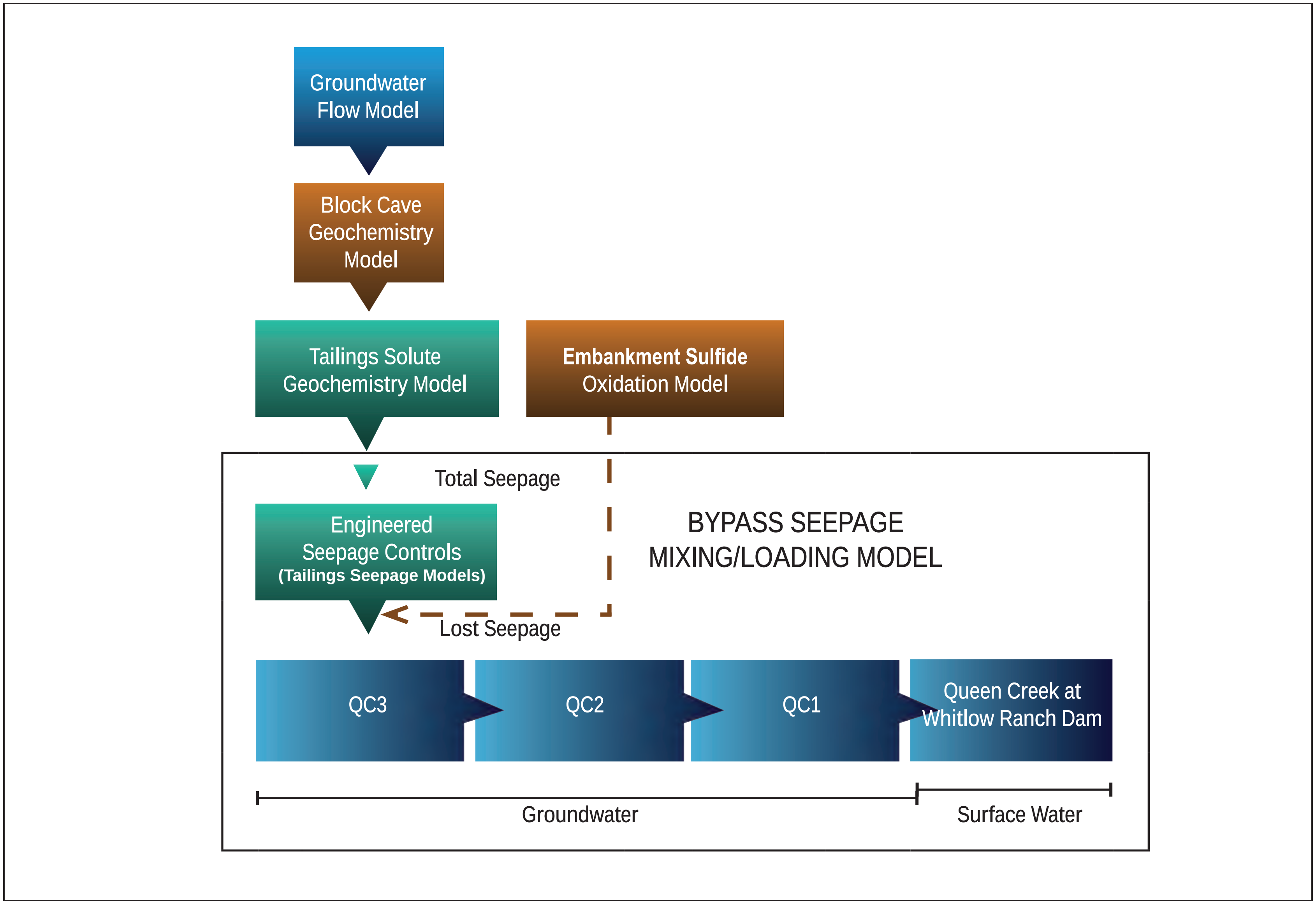


Figure 3.7.2-2. General components and process flow for water quality modeling analysis shown for Alternative 2

exposed rock surfaces to water and oxygen. These changes are estimated using a **block-cave geochemistry mode**l.

- The tailings slurry that leaves the processing facility is a mix of tailings and process water. As the tailings are deposited in the tailings storage facility, some process water is collected in the recycled water pond and sent back to the West Plant Site, but some process water stays trapped in the pore space of the tailings (this is known as "entrainment"). Eventually some of this water can seep or drain out of the tailings facility. The water quality at various locations in the tailings facility is estimated using a **tailings solute geochemistry model**.[40]
- Some of the tailings that are deposited in the tailings storage facility would remain saturated indefinitely with little possibility of oxidation occurring. However, within the embankment and beach areas, sulfide-containing minerals in the tailings would be exposed to oxygen over time, which would cause geochemical changes. These changes are estimated using the **embankment sulfide oxidation model**.
- A wide variety of engineered seepage controls are in place to intercept and collect entrained water that seeps out of the tailings facility, but despite these controls some seepage still enters the environment. The effectiveness of engineered seepage controls is estimated using a variety of **tailings seepage models**.
- The seepage not captured and entering the environment causes water quality changes in the downgradient aquifers and eventually in surface waters fed by those aquifers. The changes in groundwater and surface water quality are estimated using a series of **bypass seepage mixing/loading models**. Figure 3.7.2-2 shows the groundwater modeling cells (QC3, QC2, and QC1) and surface water modeling cells (Queen Creek at Whitlow Ranch Dam) downstream of Alternatives 2 and 3 – Near West tailings storage facility. The groundwater and surface water modeling cells would vary based on alternative tailings storage facility location.

Assumptions, Uncertain and Unknown Information for Geochemistry Models

BLOCK-CAVE GEOCHEMISTRY MODEL

Modeling Details

Water collects in the sump of the block-cave zone during operations and is derived from several sources:

- Groundwater inflow from the Apache Leap Tuff,
- Groundwater inflow from the deep groundwater system,
- Blowdown water from ventilation and cooling systems, and
- Excess mine service water.[41]

The block-cave sump water is pumped out during operations and incorporated into the processing water stream and therefore is one of the sources ultimately contributing to the water in the tailings facility. A block-cave geochemistry model was constructed to blend these flows and their associated chemical composition over the time of operation of the mine (Eary 2018f). Groundwater flow modeling was used to assign the flow rate for how much groundwater flows into the block-cave zone (WSP USA 2019). The rate of supply of blowdown water from ventilation systems is based on the overall water balance for the mine (WestLand Resources Inc. 2018b).

Apache Leap Tuff and deep groundwater chemistries are based upon analysis of site groundwater samples. The chemical composition of

40. The term "solute" refers to substances that are dissolved in water, such as metals like arsenic or selenium, or inorganic molecules like sulfate or nitrate.

41. Mine service water is used for a variety of tasks underground, including dust suppression and cooling. Much of this water evaporates or leaves with the ore; any excess water left over would likely find its way to the sump.

blowdown water is based upon analysis of CAP water and groundwater sourced from the Arizona Water Company (Arizona Water Company 2017). Resolution Copper projects this blended water to be composed of 25 percent CAP water and 75 percent Arizona Water Company water. Owing to evaporation associated with cooling, this water mixture is concentrated to an assumed value for total dissolved solids of 2,500 milligrams per liter (mg/L).

The model time frame is 41 years and ends with the cessation of mining. Inflows to the block-cave sump vary over time, but their chemical composition does not. The mixed waters reporting to the sump from their individual sources are equilibrated with any chemical precipitates that are oversaturated and likely to precipitate from solution. This precipitation of solids removes chemical mass from the mixed water. Results for model year 41, at the end of mining, are reported in table 3.7.2-1. Chemical weathering of wall rock and uneconomic mineralized fractured rock in the collapsed block-cave zone are assumed to not supply any chemical load to the sump water; this assumption is reflected in the column titled "Eary Block-Cave Geochemistry Model Predicted Concentrations" and is discussed in more detail after the table.

Assumptions, Uncertain and Unknown Information

The block-cave geochemistry model, like all models, necessarily includes assumptions in its effort to forecast future conditions. Assumptions are made to constrain model components that cannot be conclusively known and therefore represent uncertainty in the model results. The key assumptions in the block-cave geochemistry model, the level of uncertainty, and their potential implications are summarized here:

- The model assumes the chemistry of various water sources (Apache Leap Tuff, deep groundwater system, CAP water, Desert Wellfield) remains constant over time. In reality, the chemical load[42] from these sources could increase or decrease over time.
  - Applies to: all action alternatives.
  - Possible outcome if real-world conditions differ from the assumption: Modeled tailings seepage concentrations could be higher or lower.
  - Likely magnitude of effect for all action alternatives: Low. Water sources are primarily from large aquifers that change slowly in response to climatic trends and are not the primary source of chemical loading to the block-cave zone.
- The model assumes fractured rock in the collapsed block-cave zone does not contact oxygen and chemical weathering does not supply any chemical load to the sump water. If chemical weathering occurs, percolation of groundwater through these rocks could transport weathering products to the sump.
  - Applies to: all action alternatives.
  - Possible outcome if real-world conditions differ from the assumption: Sump water and modeled tailings seepage concentrations could be higher.
  - Likely magnitude of effect for all action alternatives: High. Possible outcomes are bracketed by the two sump chemistries shown in table 3.7.2-1 (Eary 2018f; Hatch 2016). The sump water only makes up between 20 and 24 percent of the inflow to the West Plant Site (see Ritter (2018)), but the loads for all constituents of concern could substantially increase if this assumption does not match real-world conditions. See section "Overall Effect of Uncertainties on the Model Outcomes" later in this section for more discussion.

42. The word "loading" is used throughout this section. In this context, "chemical loading" or "pollutant loading" refers to the total amount, by weight, of a chemical, metal, or other pollutant that enters the environment over some time period (usually a day or year). For example, the total selenium load entering the environment from Alternative 2 seepage has been estimated as 0.0242 kilograms per day.

Table 3.7.2-1. Modeled block-cave sump water chemistry

Constituent	Eary Block-Cave Geochemistry Model* Predicted Concentrations (mg/L)	Hatch Block-Cave Geochemistry Model† Predicted Concentrations (mg/L)	Arizona Aquifer Water Quality Standard (mg/L)
Ca	237	434	–
Mg	63	147	–
Na	130	181	–
K	28	85	–
Cl	46	85	–
HCO_3	114	19.9	–
SO_4	934	2,247	–
SiO_2	22.4	17	–
F	2.3	Not reported	4
N	0.8	Not reported	–
Al	0.0857	9.3	–
Sb	0.0047	**0.035**	0.006
As	0.0227	0.013	0.05
Ba	0.0199	0.02	2
Be	0.0003	**0.036**	0.004
B	0.342	0.48	–
Cd	0.0008	**0.19**	0.005
Cr	0.0027	**0.241**	0.1
Co	0.0063	2.72	–
Cu	0.0158	141	–
Fe	0.0025	0.1	–
Pb	0.005	**0.088**	0.05
Mn	0	14.2	–
Hg	Not reported	0.018	0.002
Mo	0.0135	0.000012	–
Ni	0.0076	**2.5**	0.01
Se	0.0051	**0.5**	0.05
Ag	0.0039	0.165	–
Tl	**0.0043**	**0.009**	0.002
Zn	0.221	8.2	–

continued

Table 3.7.2-1. Modeled block-cave sump water chemistry *(cont'd)*

Constituent	Eary Block-Cave Geochemistry Model* Predicted Concentrations (mg/L)	Hatch Block-Cave Geochemistry Model† Predicted Concentrations (mg/L)	Arizona Aquifer Water Quality Standard (mg/L)
pH s.u.	8.58	5.05	–
TDS	1528	Not reported	–

Notes: Modeled concentrations that are above Arizona aquifer water quality standards are show in bold and shaded. Model data are not specific to total or dissolved fractions.

Dash indicates no Arizona numeric aquifer water quality standard exists for this constituent.

* Eary (2018f)

† Hatch (2016)

- The model assumes that weathering products from ore remain with the ore and report to the tailings storage facility. These weathering products could rinse off ore and report to the sump.
    - Applies to: all action alternatives.
    - Possible outcome if real-world conditions differ from the assumption: Sump chemical load could be higher, but whether traveling with ore or reporting to sump, the weathering products enter the process stream either way, and there would be no change to the overall tailings seepage models.
    - Likely magnitude of effect for all action alternatives: None.

TAILINGS SOLUTE GEOCHEMISTRY MODEL

Modeling Details

The water balance for the mine is complex, with multiple sources and recycling loops, and how these sources mix forms the fundamental basis for predicting the water quality in the tailings facility. The water balance differs for each tailings alternative (Golder Associates Inc. 2018a; Klohn Crippen Berger Ltd. 2018a, 2018b, 2018c, 2018d; WestLand Resources Inc. 2018b). Chemical loading inputs are applied to each water source, and the resulting water quality is calculated with a mixing model (PHREEQC) for the entire operational life of the mine, with a different analysis conducted for each alternative (Eary 2018a, 2018b, 2018c, 2018d, 2018e, 2018g). Water quality is modeled for six different locations:

- the mixture of water entering the West Plant Site;
- the PAG recycled water pond (not applicable to Alternative 4 – Silver King);
- the NPAG recycled water pond (not applicable to Alternative 4 – Silver King);
- the water within the pore space of the tailings embankment;
- the seepage collection ponds; and
- the seepage lost to underlying aquifers not captured by the seepage collection ponds.

The tailings solute geochemistry model determines the chemistry of all water and chemicals reporting to the tailings storage facility, and the degree of evaporative concentration. It produces estimates of dissolved constituent concentrations in the tailings storage facility, a portion of which is lost seepage that is used in modeling impacts on downgradient water resources. The tailings solute geochemistry model results are strongly affected by the water balance for the tailings storage facility, which provides flows for the various components reporting to the

tailings storage facility and accommodates for evaporative loss. This loss is used in the tailings solute geochemistry model to concentrate dissolved chemical constituents.

Assumptions, Uncertain and Unknown Information

The tailings solute geochemistry model is largely a mathematical process of tracking and combining chemical masses, given various input flow rates and chemical concentrations. While the inputs have uncertainty (such as the block-cave sump chemistry), the model itself highly certain. The release of chemical mass from the ore during processing is also part of the tailings solute geochemistry model; this is based on rates observed during site-specific metallurgical testing and is considered reasonable with relatively low uncertainty.

EMBANKMENT SULFIDE OXIDATION MODEL

Modeling Details

During operations, the tailings that are most likely to experience oxidation of sulfide minerals—the PAG tailings—would be kept in a subaqueous state with an overlying water cap (a minimum of 10 feet deep) to prevent oxygen from reaching and interacting with the tailings. During closure, the water cap would gradually be replaced with a cover of NPAG tailings and a reclamation cover to achieve the same result. The fine-grained tailings on the interior of the facility are expected to exhibit a low vertical permeability and a high moisture content, and oxygen is not expected to penetrate the tailings at rates sufficient to affect seepage chemistry for hundreds of years (Wickham 2018). This would eliminate (or greatly reduce) the risk of acid rock drainage from the PAG tailings, which would otherwise have the potential to impact downstream waters and aquifers.

However, the embankments of the NPAG tailings facility would be constructed of well-drained cyclone sands. Oxygen would be able to enter these areas and react with sulfide minerals over time. The same is true of the entirety of the filtered tailings facility (Alternative 4 – Silver King). The embankment sulfide oxidation model determines the chemical quality of seepage derived from the oxidation occurring in the tailings embankment for the 41 years of operation and an additional 204-year post-closure period[43] (Wickham 2018).

Assumptions, Uncertain and Unknown Information

Chemical loading is calculated using theoretical concepts regarding oxygen movement into the tailings that make up the embankment, and an experimentally derived rate equation for the oxidation of sulfide minerals. The rate equation’s validity is supported by field and laboratory testing, and the movement of oxygen is supported by literature-based studies; both assumptions are considered reasonable for the estimate of embankment seepage water quality with relatively low uncertainty.

TAILINGS SEEPAGE MODELS

Modeling Details

Management of water in the tailings storage facility must accomplish a variety of outcomes. For structural integrity, it is desirable to allow water to leave the NPAG tailings storage facility and the tailings embankment in the form of seepage (see section 3.10.1 for a further discussion of tailings stability). However, it is undesirable to allow that seepage to enter downstream aquifers or surface waters in amounts that can cause water quality problems. For PAG tailings, which tend to generate the worst seepage water quality, not only is it undesirable to allow seepage from PAG tailings to enter the environment but it is also necessary to prevent seepage in order to maintain saturation of the PAG tailings to prevent oxidation.

43. The duration of the geochemical modeling matches a global decision made by the Tonto National Forest with input from the Groundwater Modeling Workgroup that quantitative modeling results are not reliable longer than 200 years in the future. This is described more in section 3.7.1.

Each alternative would use a specific set of engineered seepage controls that are built into the design in order to accomplish these goals. These include such controls as liners, blanket and finger drains, seepage collection ponds, and pumpback wells. The specific controls incorporated into each alternative design are described in section 3.7.2.4.

For a given tailings storage facility, estimates have been made of the “total seepage” and the “lost seepage.” Total seepage is all water that drains from the tailings storage facility by gravity. Lost seepage is seepage that is not recovered with the engineered seepage controls. Lost seepage is assumed to discharge to the environment. The role of consolidation of the tailings over time was incorporated into the seepage estimates, described further in Garrett and Newell (2018d).

All alternative designs use a strategy of layering on engineered seepage controls to reduce the amount of lost seepage to acceptable levels. Some of these controls, such as foundation preparation, liners, drains, and seepage collection ponds, are implemented during construction of the facility. Other controls, such as auxiliary pumpback wells, grout curtains, or additional seepage collection ponds, would be added as needed during operations depending on the amounts of seepage observed and the observed effectiveness of the existing controls.

The amount of seepage entering the environment is modeled in a variety of ways, depending on alternative (Klohn Crippen Berger Ltd. 2019d).[44] Common to all of these models is that the engineered seepage controls described in section 3.7.2.4 are assumed to be in place, and the combined effectiveness of the layered engineered seepage controls is a key assumption in the ultimate predicted impacts on water.

The level of engineered seepage controls for each alternative was assigned based on practicability and initial modeling estimates of the “allowable seepage” (Gregory and Bayley 2018a). Allowable seepage is the estimated quantity, as a percentage of total seepage, that can be released without resulting in groundwater concentrations that are above Arizona aquifer water quality standards, or surface water concentrations that are above Arizona surface water quality standards. The allowable seepage target is a significant driver for the design of each facility; engineered seepage controls were increased in the design as needed to limit lost seepage to the allowable amount.

Comparison of Engineered Seepage Controls to a Fully Lined Facility

During alternatives development, the concept of a fully lined tailings storage facility was pursued. Eventually this concept was eliminated from detailed analysis, although liners are still used in some areas and some of the techniques used to control seepage that have been incorporated into the design accomplish similar results as a liner. A full description of this evolution is contained in Garrett and Newell (2018d), as are calculations of expected seepage from a fully lined facility. These calculations are used for comparison in section 3.7.2.4.

Assumptions, Uncertain and Unknown Information

Engineered seepage controls incorporated into the tailings storage facility design serve to ensure geotechnical stability/safety and recover a percentage of the total seepage released, in order to meet the limits of allowable seepage. The bypass seepage mixing/loading model is reliant on the amount of lost seepage, and therefore reliant on both the feasibility and effectiveness of the engineered seepage controls. Details of the engineered seepage controls (broken out by Levels 0 through 4) and an assessment of their ability to control seepage are discussed in section 3.7.2.4. The key assumptions in the tailings seepage models, and the level of uncertainty are summarized here:

- The tailings seepage models calculate seepage during the mine life under full-buildout conditions, with gradual increases in acreage and tapering of seepage over time.
    - Applies to: all action alternatives.

44. The choice of models used to estimate seepage for each alternative was based on the specific location, design, level of information, and seepage controls. Further details of the models are contained in Newell and Garrett (2018d).

- Possible outcome if real-world conditions differ from the assumption: Modeled tailings seepage during operations is overestimated.
- Likely magnitude of effect for all action alternatives: Low to none. This approach overestimates chemical loading, rather than underestimates it, and therefore is conservative. In addition, this applies only during the operational life and would not affect the post-closure seepage estimates.

- Incomplete removal of alluvial channels within the interior of the tailings storage facility would allow for faster transport of seepage.
  - Applies to: Alternatives 2, 3, and 4.
  - Possible outcome if real-world conditions differ from the assumption: Seepage reaches finger drains and blanket drains faster.
  - Likely magnitude of effect for Alternatives 2, 3, and 4: Low to none. This would only enhance the operation of the finger and blanket drainage system, which captures seepage and pumps it back to the recycled water pond.
- The seepage estimates do not account for possible preferential flow along minor faults in the bedrock underlying the tailings storage facility footprint.
  - Applies to: Alternatives 2, 3, and 4.
  - Possible outcome if real-world conditions differ from the assumption: Seepage bypasses drains and seepage collection ponds, increasing amount of lost seepage and chemical load to downstream aquifer.
  - Likely magnitude of effect for Alternatives 2 and 3: Low to none. While seepage would bypass the drains and seepage collection ponds, for seepage to enter the environment assumes that all foundation treatments (Level 1, Level 4) were ineffective as well as the downstream grout curtain (Level 2, Level 4) and auxiliary pumpback wells (Level 4). The variety of layered controls have a high likelihood of capturing this seepage.
  - Likely magnitude of effect for Alternative 4: Moderate. This alternative has fewer layered seepage controls, and places sole reliance on the drains and seepage collection ponds.
- The modeling used to estimate seepage efficiency assumes ideal placement of all pumpback wells, embankments, and grout curtains. Pumpback wells might not be located in ideal locations and therefore allow more flow to escape than modeled.
  - Applies to: Alternatives 2 and 3.
  - Possible outcome if real-world conditions differ from the assumption: More seepage escapes, increasing chemical load to downstream aquifer.
  - Likely magnitude of effect for Alternatives 2 and 3: Low. The primary ring of seepage collection dams (Level 1) is located along alluvial drainages which are highly likely to be the preferential flow paths. The secondary ring of seepage collection dams (Level 3), auxiliary pumpback wells (Level 4), and grout curtains (Level 2, Level 4) are controls that would be installed during operations as needed. Placement of these would be driven by direct observation, and it is reasonable to assume they would be targeted to areas of concern.
- The modeled efficiencies for Alternative 2 (99 percent) and Alternative 3 (99.5 percent) could be difficult to achieve in practice. For instance, the length of the Level 4 grout curtain for both alternatives (approximately 7.5 miles) is believed to be larger by a factor of 10 than any other grout curtain in the United States. Similarly, for comparison, the full suite of

engineered seepage controls would result in 97 percent less seepage than a fully lined facility.

- Applies to: Alternatives 2 and 3
- Possible outcome if real-world conditions differ from the assumption: More seepage escapes, increasing chemical load to downstream aquifer.
- Likely magnitude of effect for Alternatives 2 and 3: Moderate to high. The overall reliance on a variety of engineered seepage controls in a layered defense reduces the likelihood that the failure of any one control would change the outcome. For the Near West location, however, the proximity to Queen Creek provides little room for flexibility to add or modify controls during operations.

- Unlike Alternatives 2 and 3, there is limited information on the hydrology and geology of the proposed Silver King tailings location (Alternative 4). Seepage capture was not modeled, but instead based on professional judgment of the design engineers and an understanding of the potential flow pathways for seepage. Results could vary widely based on field conditions encountered.
  - Applies to: Alternative 4.
  - Possible outcome if real-world conditions differ from the assumption: More seepage escapes, increasing chemical load to downstream aquifer.
  - Likely magnitude of effect for Alternative 4: Moderate. Filtered tailings involve less initial seepage to control, but concentrations of metals are generally higher. Complex and poorly understood geology complicates control efforts. However, at this location there is also potentially room to layer on additional seepage controls downstream.

- Alternative 5 has limited site-specific information on the foundation conditions. However, the general characteristics of the aquifer are reasonably well understood from site-specific geophysics (resistivity, seismic, and gravity surveys), surface geology mapping, review of records and logs from 20 to 30 wells in the near vicinity, and site-specific water levels from nine wells in the near vicinity (Fleming, Kikuchi, et al. 2018; hydroGEOPHYSICS Inc. 2017).
  - Applies to: Alternative 5.
  - Possible outcome if real-world conditions differ from the assumption: More seepage escapes, increasing chemical load to downstream aquifer.
  - Likely magnitude of effect for Alternative 5: Low to none. Unlike Alternatives 2, 3, and 4, the large volume of groundwater flow in the substantial alluvial aquifer downstream creates dilution and can accept larger amounts of seepage without resulting in concentrations above water quality standards. In addition, the lost seepage as modeled is based on a reduced pumping amount from the pumpback well system. Additional pumping could take place as needed. In addition, the nearest perennial water is several miles downstream, so there is substantial room to add or modify seepage controls.
  - Alternative 6 has limited site-specific information on the foundation conditions. The general characteristics of the aquifer are understood based on surface geology mapping, review of records and logs from 35 wells in the area (10 within the footprint), including six with driller’s logs, and site-specific water levels from 11 wells in the near vicinity (Fleming, Shelley, et al. 2018). In addition, the geological units (Gila Conglomerate) at this location are similar to Alternatives 2 and 3, allowing some reasonable extrapolation of their characteristics. However, this site is not as well understood as

Alternatives 2 and 3, nor does it have as large a downstream aquifer as Alternative 5.

- Applies to: Alternative 6.
- Possible outcome if real-world conditions differ from the assumption: More seepage escapes, increasing chemical load to downstream aquifer.
- Likely magnitude of effect for Alternative 6: Moderate to low. Although not as large as Alternative 5, the volume of groundwater flow in the alluvial aquifer downstream creates dilution and can accept larger amounts of seepage without resulting in concentrations above water quality standards. The flow characteristics of the downstream alluvial aquifer are relatively straightforward, and the spatial extent is well-defined from surface geological mapping. The thickness of the aquifer is uncertain, however, which could affect the overall amount of water available for dilution in the modeling. Seasonal fluctuations in water levels could affect the aquifer capacity. Countering these uncertainties, the relatively narrow aquifer width likely makes existing planned controls (like the grout curtain) simpler to implement, and with the nearest perennial water over a dozen miles downstream, there is substantial room to add or modify seepage controls.

BYPASS SEEPAGE MIXING/LOADING MODELS

Modeling Details

The water quality of the tailings seepage (estimated using the tailings solute geochemistry models), the changes in water quality from the embankment (estimated using the embankment sulfide oxidation model), and the predicted amounts of lost seepage from the facility (estimated using the tailings seepage models), are input into a series of bypass seepage mixing/loading models. These models predict the changes in aquifer water quality as lost seepage flows downgradient from each tailings storage facility. The bypass seepage mixing/loading model uses the Goldsim software package to calculate the mass balance and account for dilution from groundwater present in a series of connected mixing cells. The model cells and framework are slightly different for each alternative; all models are run for the 41 years of operation and an additional 204 years post-closure.

- **Near West (Alternatives 2 and 3)**. The mixing/loading model for Alternatives 2 and 3 estimates groundwater quality in five different mixing cells, starting with Roblas Canyon and Potts Canyon, then flowing into Queen Creek. Queen Creek is represented by three mixing cells, which lead downstream to where the model ends at Whitlow Ranch Dam, where groundwater emerges as surface water (Gregory and Bayley 2018e). Background groundwater quality is derived from a well located adjacent to Queen Creek, using the median of nine samples collected between May 2017 and February 2018. Background surface water quality is derived from the median of 15 samples collected at Whitlow Ranch Dam between March 2015 and December 2017.
- **Silver King (Alternative 4)**. Even though this alternative is composed of filtered tailings, some seepage is still expected to occur with Alternative 4, though a very small amount, compared with Alternatives 2, 3, 5 and 6. The downstream mixing model estimates groundwater quality in nine cells, which start with Potts Canyon, Silver King Wash, and Happy Camp Wash East and West, then flowing into Queen Creek. Queen Creek is represented by five mixing cells, which lead downstream to where the model ends at Whitlow Ranch Dam, where groundwater emerges as surface water (Gregory and Bayley 2018b). Background groundwater and surface water quality are derived from the same sources as Alternatives 2 and 3.
- **Peg Leg (Alternative 5)**. The Peg Leg location is fundamentally different from Alternatives 2, 3, and 4 in that much of the facility overlies a large alluvial aquifer, resulting in relatively large seepage rates, compared with other alternatives.

The downstream mixing model estimates groundwater quality in five cells along Donnelly Wash, leading to the Gila River where groundwater emerges as surface water (Gregory and Bayley 2018c). Background groundwater quality is derived from a single sample in September 2017 from a well located adjacent to Donnelly Wash. Background surface water quality is derived from a single sample in November 2018 from the Gila River at the confluence with Donnelly Wash.

- **Skunk Camp (Alternative 6)**. The Skunk Camp model is similar to the Peg Leg model, with the alluvial aquifer associated with Dripping Spring Wash located downstream. The downstream mixing model estimates groundwater quality in five cells along Dripping Spring Wash, leading to the Gila River, where groundwater emerges as surface water (Gregory and Bayley 2018d). Background groundwater quality is derived from a single sample in November 2018 from a well located adjacent to Dripping Spring Wash. Background surface water quality is derived from a single sample in November 2018 from the Gila River at the confluence with Dripping Spring Wash.

A relatively straightforward mixing cell model is used to evaluate the impact on water, as shown in figure 3.7.2-2. Lost seepage from a given tailings storage facility alternative mixes with the flow of underlying groundwater in the first model cell. The flow of water and dissolved chemicals from this cell passes to the next cell downgradient and is combined with any other flows reporting to that cell. Flows are passed from one groundwater cell to the next until it discharges to a receiving surface water, which is the last cell in the model. At each step, the concentrations of chemical constituents are calculated. The model dimensions of the groundwater cells dictate the amount of dilution that is achieved on mixing with lost seepage; the larger the cells, the greater the diluting effect.

The specific geographic points selected to represent the aquifer and surface water modeled impacts are shown in figure 3.7.2-3.

Assumptions, Uncertain and Unknown Information

The uncertainties described for the block-cave geochemistry model, the tailings solute geochemistry model, and the embankment sulfide oxidation model also add to the uncertainty of the bypass seepage mixing/loading model. Specific uncertainties that affect the bypass seepage mixing/loading model include the following:

- The size of the groundwater cells in the model affects the amount of dilution and the outcome.
  - Applies to: all action alternatives.
  - Possible outcome if real-world conditions differ from the assumption: More or less dilution occurs, changing chemical load to downstream aquifers and perennial waters.
  - Likely magnitude of effect for Alternatives 2 and 3: Low. Substantial site-specific investigation has taken place at the Near West location; this location has the most hydrologic and geological information of any of the alternatives.
  - Likely magnitude of effect for Alternative 4: Low. While the hydrology and geology near the Silver King location is uncertain, the groundwater mixing component happens downstream in Queen Creek, which is relatively well-defined.
  - Likely magnitude of effect for Alternative 5: Low to none. Substantial site-specific investigations have occurred at the Peg Leg location that define the size of the aquifer, which even with uncertainties is substantial.
  - Likely magnitude of effect for Alternative 6: Moderate. The spatial extent of the downstream aquifer is well defined, and characteristics of the aquifer are reasonably understood. However, the thickness of the aquifer is

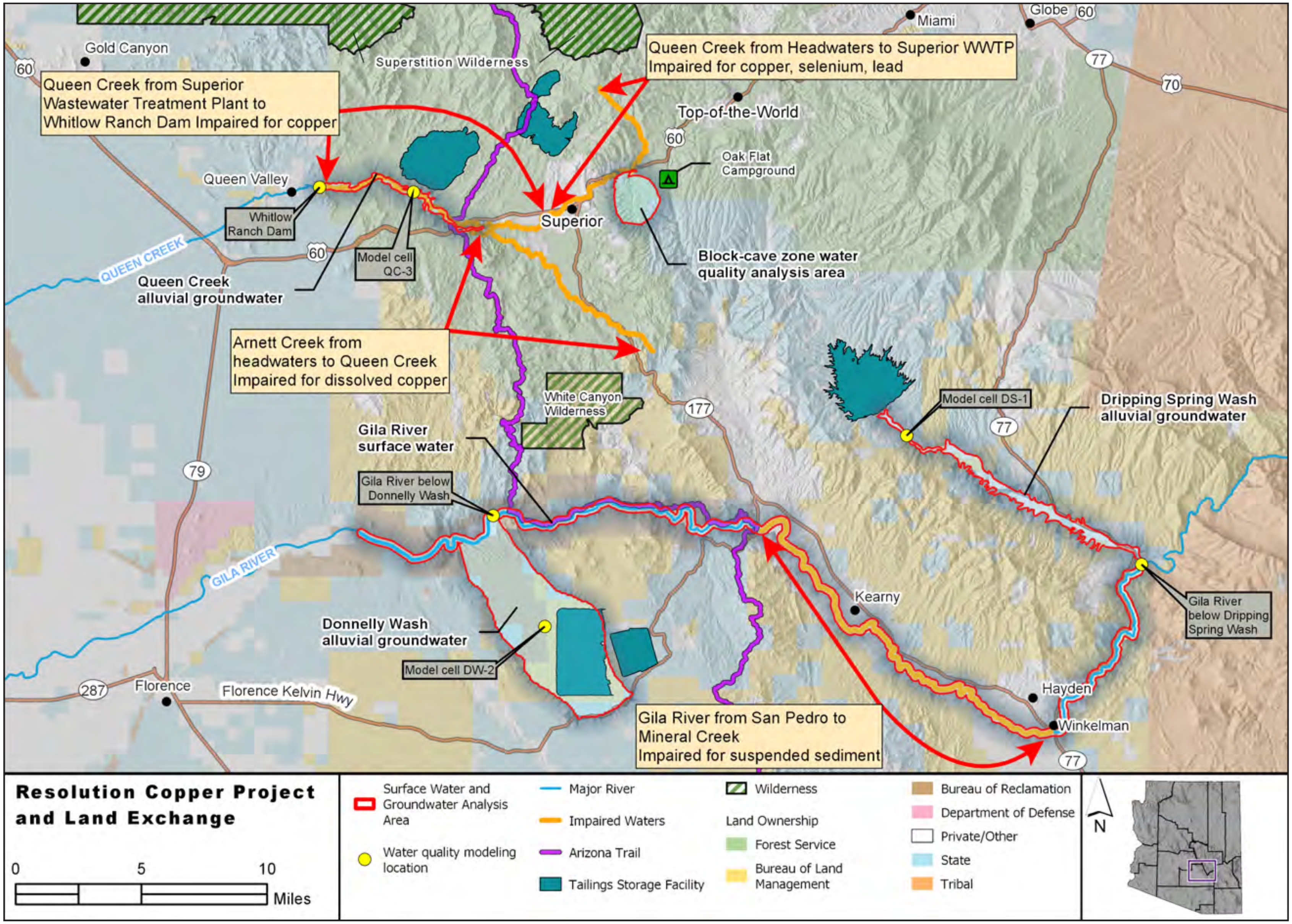


Figure 3.7.2-3. Water quality modeling locations and impaired waters

uncertain, which would directly affect the amount of water available for dilution in the model.

- There is a limited knowledge of baseline aquifer water chemistry.
  - Applies to: all action alternatives.
  - Possible outcome if real-world conditions differ from the assumption: Baseline chemistry may be higher or lower, leading to different combined concentrations in downstream aquifers.
  - Likely magnitude of effect for Alternatives 2, 3, and 4: Low. Water quality modeling used the median results from nine different samples collected from the nearest downstream well.
  - Likely magnitude of effect for Alternative 5: Moderate. The water quality modeling was based on a single groundwater sample. While water quality modeling did not result in concentrations near aquifer water quality standards for most constituents, selenium approaches the standard late in the modeling run. Even moderate changes in selenium based on additional groundwater sampling could change the outcome of the models.
  - Likely magnitude of effect for Alternative 6: Moderate to low. The water quality modeling was based on a single groundwater sample. However, water quality modeling did not result in concentrations near aquifer water quality standards, allowing some room for variation as future samples are collected.
- There is a limited knowledge of baseline surface water chemistry.
  - Applies to: all action alternatives.
  - Possible outcome if real-world conditions differ from the assumption: Baseline chemistry may be higher or lower, leading to different assimilative capacity and different predicted concentrations in downstream perennial waters.
  - Likely magnitude of effect for Alternatives 2, 3, and 4: Low. Water quality modeling used the median results from 15 different samples collected from Queen Creek at Whitlow Ranch Dam.
  - Likely magnitude of effect for Alternatives 5 and 6: Low. The water quality modeling was based on a single surface water sample for each alternative, driven by the necessity to have recent surface water quality results at two specific locations (Donnelly Wash and Dripping Spring Wash). A longer period of record exists for the Gila River at other locations and these samples have been assessed against the values used; the model outcomes would not substantially change if surface water quality varied similar to the historic record (see Newell and Garrett (2018d)).
- Modeling idealizes mixing and assumes that seepage fully mixes across the full width of the alluvium of Queen Creek, Donnelly Wash, or Dripping Spring Wash. Should only partial mixing occur, this would also increase concentrations in parts of the alluvial aquifer. Modeling also does not take into account seasonal flow patterns of water levels.
  - Applies to: all action alternatives.
  - Possible outcome if real-world conditions differ from the assumption: Preferential mixing or flow paths would effectively reduce the amount of dilution of seepage, resulting in higher downstream concentrations. Changing water levels could result in more or less dilution.
  - Likely magnitude of effect for all action alternatives: Moderate. Flow through alluvial aquifers is relatively straightforward to model as an idealized system, but real-world conditions (like the periodic recharge effects

of stormflow) could greatly affect the outcomes. These types of uncertainties are inherent; no amount of hydrologic investigation is likely to resolve these uncertainties.

OVERALL EFFECT OF UNCERTAINTIES ON THE MODEL OUTCOMES

As with all modeling, the modeling used to estimate water quality impacts for each alternative contains assumptions and uncertainty that limit the accuracy and reliability of the associated results.

The model construction includes some intentional bias to skew results that produce a greater negative impact and therefore provide the greatest environmental protection. Examples include the following:

- The assumption that life-of-mine discharge from the tailings storage facility remains at the highest levels associated with the drain down process, rather than decreasing over time. This maximizes the modeled chemical discharge from the tailings storage facility.
- The model does not consider any geochemical processes in the groundwater and surface water flow that might lower concentrations. Examples include potential chemical precipitation of oversaturated solids, or adsorption of chemical constituents onto aquifer solids, which can both lower concentrations in the water.
- For comparisons against surface water standards, median flow values were used which is appropriate when replicating baseflow. Concentrations during runoff events would be expected to be lower due to dilution from stormflows. However, it should be noted that lower flow conditions can occur during the year that would not be reflected by median flow conditions, and for some constituents like copper, studies suggest that stormflows might increase in copper concentrations (Louis Berger Group Inc. 2013).
- Variations in hardness can change surface water quality standards for some metals, with increasing hardness resulting in a higher water quality standard; for the comparisons in section 3.7.2.4, the best available information on existing hardness was used (as calculated from calcium and magnesium concentrations).

A number of uncertainties have been disclosed in this section that affect the ultimate outcome of the water quality modeling. These are summarized in table 3.7.2-2.

Many of the uncertainties identified could result in either higher or lower concentrations in modeled outcomes, or overall would be expected to have a low (or no) impact on the outcomes.

A number of uncertainties reflect limited information on the geology and hydrology at alternative tailings locations or limited baseline water quality samples. This does not mean that the models are unrealistic or unreasonable. They rely on the best available hydrologic and geological information and make reasonable assumptions about aquifer conditions. Future hydrologic and geological investigations at these locations would reduce some uncertainty and refine some model parameters; the overall flow regime of the downstream aquifers and surface waters is understood well enough that the model framework would likely remain the same.

One of the most uncertain aspects of the modeling is the assumption about oxidation in the block-cave zone. Two different models of the geochemistry of the block-cave zone have been conducted, one assuming that oxidation occurs (Hatch 2016) and one assuming that it does not (Eary 2018f). The block-cave geochemistry model used as a basis for the water quality modeling (Eary 2018f) represents the current conception of the mechanics of block-caving and ventilation of the mine and how that would affect the presence of oxygen in the cave zone; this is considered a reasonable interpretation. However, the earlier interpretation—while not as advanced—is also a reasonable interpretation, and this source of uncertainty could result in higher concentrations that would cascade through the water quality modeling.

Table 3.7.2-2. Compilation of magnitude of uncertainties disclosed for water quality modeling

Modeling Component/ Uncertainty	Potential Effect on Modeled Tailings Seepage	Alternative 2 Likely Magnitude of Effect on Outcomes	Alternative 3 Likely Magnitude of Effect on Outcomes	Alternative 4 Likely Magnitude of Effect on Outcomes	Alternative 5 Likely Magnitude of Effect on Outcomes	Alt 6 Likely Magnitude of Effect on Outcomes
Block-cave model						
Source water chemistry could vary	Higher or lower	Low	Low	Low	Low	Low
Cave-zone in-situ weathering could occur	Higher	High	High	High	High	High
Weathering products stay with ore	None	None	None	None	None	None
Tailings seepage models						
Full-buildout seepage during operations	Lower	Low to none	Low to none	Low to none	Low to none	Low to none
Alluvial channels could remain in footprint	None	Low to none	Low to none	Low to none	–	–
Minor faults could cause preferential flow	Higher	Low to none	Low to none	Moderate	–	–
Ideal placement of controls assumed	Higher	Low	Low	–	–	–
Seepage efficiency difficult to meet	Higher	Moderate to high	Moderate to high	–	–	–
Limited site-specific hydrologic/geological information	Higher	–	–	Moderate	Low to None	Moderate to Low
Bypass seepage mixing/ loading models						
Mixing cells could be different sizes	Higher or lower	Low	Low	Low	Low to None	Moderate
Limited baseline aquifer water quality	Higher or lower	Low	Low	Low	Moderate	Moderate to Low
Limited baseline surface water quality	Higher or lower	Low	Low	Low	Low	Low
Idealized mixing	Higher	Moderate	Moderate	Moderate	Moderate	Moderate

Note: A dash indicates that this was not identified as a specific concern for this alternative

It is possible further field tests could be designed to explore this phenomenon, though these would be experimental in nature and are not industry-standard practices. The real-world effect of chemical weathering in the block-cave zone is likely bracketed by the two different models.

Conclusion as to reasonableness of models

The CEQ regulations provide guidance for dealing with incomplete or uncertain information:

> When an agency is evaluating reasonably foreseeable significant adverse effects on the human environment in an environmental impact statement and there is incomplete or unavailable information, the agency shall always make clear that such information is lacking. . . . If the incomplete information relevant to reasonably foreseeable significant adverse impacts is essential to a reasoned choice among alternatives and the overall costs of obtaining it are not exorbitant, the agency shall include the information in the environmental impact statement. (40 CFR 1502.22)

While future work or additional information could reduce some of these uncertainties, the water quality modeling results disclosed in the EIS (section 3.7.2.4) are sufficiently different between alternatives that such refinements are not "essential to a reasoned choice among alternatives." The broad conclusions in section 3.7.2.4 are not likely to change, specifically:

- It is difficult to meet water quality objectives at Alternatives 2, 3, and 4 without extensive engineered seepage controls.
- Alternatives 5 and 6 not only meet water quality objectives as modeled but have substantial additional capacity to do so, and flexibility

Forest Service disclosure and ADEQ permitting requirements

The State of Arizona has the authority to determine whether or not the proposed project would violate State water quality regulations. The person or entity seeking authorization for a regulated discharge (in this case Resolution Copper) has the responsibility to demonstrate to the State of Arizona that the regulated discharge would not violate water quality standards. This demonstration takes place through the application for and issuance of permits. Resolution Copper would be required to obtain a permit under the Arizona Pollutant Discharge Elimination System (AZPDES) program for any discharges to surface waters, including stormwater runoff, as well as an Aquifer Protection Permit (APP) for any discharges to groundwater, or discharges to the ground that could seep into groundwater.

The Forest Service is responsible for ensuring that mine operators on NFS lands obtain the proper permits and certifications to demonstrate they comply with applicable water quality standards. This constitutes compliance with the Clean Water Act (CWA). The ROD would require that Resolution Copper obtain the applicable State permits prior to approval of the final mining plan of operations, which authorizes mine activities. If the permits are issued, then ADEQ has determined that the project would be compliant with State law and identified the steps that would occur if monitoring indicates noncompliance.

While the permitting process provides an assurance to the public that the project would not cause impacts on water quality, it does not relieve the Forest Service of several other responsibilities:

- The Forest Service has a responsibility to analyze and disclose to the public any potential impacts on surface water and groundwater as part of the NEPA process, separate from the State permitting process.
- The role of the Tonto National Forest under its primary authorities is to ensure that mining activities minimize adverse environmental effects on NFS lands and comply with all applicable laws and regulations. As such, the Forest Supervisor

ultimately cannot select an alternative that is unable to meet applicable laws and regulations.[45] However, it may be after the EIS is published when permits are issued by ADEQ that demonstrate that the project complies with state laws. In the meantime, it would be undesirable for the Forest Service to pursue and analyze alternatives that may not be able to comply. Therefore, a second goal of the analysis in this EIS is to inform the Forest Supervisor of alternatives that may prove difficult to permit.

The analysis approaches used by the Forest Service in this EIS likely differ from those that ADEQ would use in assessing and issuing permits. ADEQ would use the assumptions, techniques, tools, and data deemed appropriate for those permits. The Forest Service has selected to use a series of simpler mixing-cell models to provide a reasonable assessment of potential water quality impacts that is consistent with the level of hydrologic and geological information currently available for the alternative tailings sites. This approach is sufficient to provide the necessary comparison between alternatives and assess the relative risk of violation of water quality standards. It is understood different analysis may be conducted later when ADEQ is reviewing permit applications for the preferred alternative.

There are two specific additional aspects of the analysis in this section of the EIS that have a bearing on the ADEQ permitting process: assimilative capacity, and impaired waters.

ASSIMILATIVE CAPACITY

Assimilative capacity is the ability for a perennial water to receive additional pollutants without being degraded; assimilative capacity is calculated as the difference in concentration between the baseline water quality for a pollutant and the most stringent applicable water quality criterion for that pollutant.

Under Arizona surface water regulations, the addition of a pollutant may be considered "significant degradation" of a perennial water if, during critical flow conditions, the regulated discharge consumes 20 percent or more of the available assimilative capacity for each pollutant of concern (Arizona Administrative Code R18-11-107.01(B)). The addition of contaminants to surface waters through seepage could result in a reduction in the assimilative capacity of perennial waters. The EIS therefore contains an analysis of reductions in assimilative capacity.

The regulatory determination of significant degradation of perennial waters is under the purview of the State of Arizona. This determination is usually made when a permit is requested for a discharge directly to surface waters. However, Resolution Copper is not proposing any direct discharges to surface waters. Alternatively, ADEQ could consider the indirect effects of seepage from the tailings storage facility to surface waters under the APP program, or under a CWA Section 401 water quality certification (which is only done if a CWA Section 404 permit is required).

The 20 percent threshold that defines significant degradation is not absolute; if ADEQ decides to assess antidegradation standards as part of a permitting action, there are also provisions in Arizona regulations for degradation to be allowed, provided certain criteria are met (Arizona Administrative Code R18-11-107.C).

In other words, neither the regulatory need to assess assimilative capacity, nor the consequences of exceeding the 20 percent threshold can be assessed outside of a specific permitting decision by ADEQ. Regardless, the Forest Service responsibility for the DEIS is to disclose possible water quality concerns. This includes the reduction in

45. Note that Alternative 6 would involve a tailings facility located off of Federal lands, and permitting the tailings facility would not be part of the Federal decision. In this case, the State permitting process that would ensue would require that applicable laws and regulations be met.

assimilative capacity of a perennial water. For this purpose, a threshold of 20 percent loss in assimilative capacity is used.[46]

IMPAIRED WATERS

Under the CWA, the State of Arizona must identify waters that are impaired for water quality.[47] As with assimilative capacity, the regulatory determination of how impaired waters could be affected by a discharge is solely under the purview of the State of Arizona.

For the purposes of disclosure, the Forest Service approach in the EIS is to identify what surface waters have been determined to be impaired, where contaminants from the project could enter these surface waters and exacerbate an already impaired water, and the estimated loading for constituents associated with the impairment.

Constituents of Concern

While the background references and reports contain information for the full suite of metals, inorganic constituents, and field measurements, the analysis we present in this section focuses on selected "constituents of concern." For example, appendix M of this EIS only includes graphs for the following constituents (these are constituents that are typically known to be issues for tailings facilities, or that the bypass seepage mixing/loading models have indicated may be a problem). These include the following:

- Total dissolved solids
- Sulfate
- Nitrate
- Selenium, cadmium, antimony, and copper

46. The calculation of assimilative capacity depends in part on the specific numeric surface water standard being used. Several surface water quality standards for metals change based on the hardness of the water. A hardness of 307 mg/L $CaCO_3$ was used for Queen Creek, which is based on the lowest hardness observed (sample date August 25, 2017); a hardness of 290 mg/L $CaCO_3$ was used for the Gila River below Donnelly Wash (sample date November 13, 2018); and a hardness of 242 mg/L $CaCO_3$ was used for the Gila River below Dripping Spring Wash (sample date November 9, 2018). The addition of the modeled seepage does increase hardness but only slightly (less than 2%). The values of hardness used are based on the best available information at this time; ADEQ could choose to apply different hardness values during permitting.

    The calculation of assimilative capacity also depends on specific "critical flow conditions." One technique (often called 7Q10) is to choose the lowest flow over 7 consecutive days that has a probability of occurring once every 10 years. By contrast, the seepage modeling in the EIS uses the median flow for surface waters, which is a common method of estimating baseflow conditions, because it tends to exclude large flood events. While assessing typical baseflow conditions (using the median flow) were determined to be the most appropriate method for the EIS disclosure, ADEQ could choose to apply different flow conditions during permitting.

47. "Impaired" refers to a regulatory designation under the CWA, and generally means that existing water quality is degraded to the point that an applicable water quality standard is not being attained.

Primary Legal Authorities Relevant to the Groundwater and Surface Water Quality Analysis

- Clean Water Act and Federal primary and secondary water quality standards
- State of Arizona Aquifer Water Quality Standards and the Aquifer Protection Permit program
- State of Arizona Surface Water Quality Standards and the Arizona Pollutant Discharge Elimination System program (delegated primacy for Clean Water Act Section 402)

3.7.2.3 Affected Environment

Relevant Laws, Regulations, Policies, and Plans

For the most part, impacts on groundwater and surface water quality fall under State of Arizona regulations, which are derived in part from the CWA. Additional details of the regulatory framework for groundwater and surface water quality are captured in the project record (Newell and Garrett 2018d).

Existing Conditions and Ongoing Trends

This section discusses three aspects of the affected environment:

- Existing groundwater quality for various aquifers, including what types and quantity of data have been collected to date; the general geochemistry of the groundwater for major constituents; the occurrence and concentrations of constituents of concern, compared with water quality standards; the age of the groundwater; and existing trends in groundwater quality.
- Existing surface water quality for various streams, including what types and quantity of data have been collected to date; the general geochemistry of surface waters for major constituents; and the occurrence and concentrations of constituents of concern, compared with water quality standards.
- Characterization of mine rock ore, and tailings, including the types and quantity of data for different geological units and alteration types that have been collected to date, and the static and kinetic laboratory testing undertaken to describe the likely changes in water quality when exposed to oxygen in the presence of sulfide minerals.

EXISTING GROUNDWATER QUALITY

Types of Groundwater Present

As more fully described in Section 3.7.1, Groundwater Quantity and Groundwater-Dependent Ecosystems, three types of groundwater exist in the area: shallow groundwater occurring in shallow alluvial materials, perched zones, or shallow fractures; the Apache Leap Tuff aquifer; and the deep groundwater system (units generally below the Whitetail Conglomerate, and extending into the Superior Basin) as seen in figure 3.7.1-4. These groundwater systems are identified as separate based on the different ages of the water within them and because they do not appear to be hydraulically connected based on aquifer testing.

The tailings facilities for Alternatives 2, 3, and 4 in the Superior Basin include shallow alluvial materials along washes and underlying fractured hard rock units like the Gila Conglomerate, which are assumed to be in hydraulic connection with the deep groundwater system. The tailings facilities for Alternatives 5 and 6 are geographically separate from the Superior Basin and overlie alluvial aquifers associated with Donnelly Wash and Dripping Spring Wash, respectively, with some hard rock units along the margins of the facilities.

Period of Record for Groundwater Quality Data

Groundwater quality data have been collected since monitor well drilling and development was initiated in 2003, and collection continues into the

present. Groundwater samples from each monitoring well are analyzed for common dissolved constituents when the wells are completed, and then periodically thereafter. Overall, 31 wells in the project area have been sampled since 2003, and a total of 150 samples has been collected to characterize groundwater in the project area through 2015. These samples are largely focused on the East Plant Site and surrounding areas.

Near the West Plant Site, 48 wells have been developed and sampled, yielding 102 samples of groundwater (including duplicate samples). This sampling has largely been the result of ongoing voluntary cleanup activities at the West Plant Site, and the results are generally geared toward assessing contamination rather than hydrogeological conditions and general water quality.

Additional piezometers and monitoring wells were constructed in the Near West area in 2016 and 2017, where the tailings storage facility for Alternatives 2 and 3 would be located. Groundwater quality results from these wells have not yet been submitted.

Several other sampling locations provide the basis for background water quality in the bypass seepage mixing/loading models. These include a well near Queen Creek (nine samples between 2017 and 2018), a well near Donnelly Wash (one sample in 2018), and a well near Dripping Spring Wash (one sample in 2018).

Types of Groundwater Quality Data Collected

All samples were analyzed for a wide range of chemical constituents, including water quality measurements made on water samples in the field at the point of collection (e.g., pH, temperature) and analyses conducted by Arizona-certified analytical laboratories. Some of the constituents analyzed are directly related to water quality, including those that have regulatory standards in the state of Arizona. Other constituents such as isotopes were sampled to help understand groundwater dynamics and the potential for interaction with local surface water resources (Garrett 2018d). The number, date range, and types of samples collected are shown in table 3.7.2-3. A summary of existing groundwater quality for each aquifer is shown in appendix N, table N-1.

Table 3.7.2-3. Number of groundwater samples available for analysis

Type of Analysis	Shallow Groundwater Samples	Apache Leap Tuff Samples	Deep Groundwater Samples
General chemistry	25 (June 1986–Nov 2015)	104 (March 2004–Dec 2015)	19 (Nov 2008–Feb 2015)
Metals	25 (June 1986–Nov 2015)	105 (March 2004–Dec 2015)	19 (Nov 2008–Feb 2015)
Isotopes	24 (June 1986–May 2012)	90 (March 2004–Dec 2015)	19 (Nov 2008–Feb 2015)
Radionuclides	12 (June 2007–Dec 2008)	63 (June 2007–Dec 2015)	19 (Nov 2008–Feb 2015)

Chemical Quality of Groundwater

There are differences in water quality among the three principal groundwater sources (shallow, Apache Leap Tuff, deep groundwater system) in the project area (Montgomery and Associates Inc. 2012, 2016).[48] The shallow groundwater system can be described as a calcium/magnesium bicarbonate type with varying amounts of sulfate. The total dissolved solids content is generally low (median of 290 mg/L). Constituents in water samples from the shallow groundwater system rarely have concentrations above Arizona numeric Aquifer Water Quality Standards (AWQS) and EPA primary maximum contaminant levels, with nitrate and lead being the only constituents with concentrations above these standards. Samples also rarely have concentrations above EPA secondary maximum contaminant levels,

48. For a complete summary of the number of samples with concentrations over Arizona or EPA standards to support the qualitative terms used in this section (i.e., “rarely,” “occasionally,” “often”), see Newell and Garrett (2018d).

but this does occur for iron, manganese, sulfate, aluminum, and total dissolved solids; secondary standards are generally established for aesthetics and taste, rather than safety.

The Apache Leap Tuff aquifer has been sampled much more than either the shallow or deep groundwater systems, since it is the aquifer from which most springs and stream derive their flow. Overall the Apache Leap Tuff is a calcium-magnesium-bicarbonate water type, with low total dissolved solids (median of 217 mg/L). Constituents in water samples from the Apache Leap Tuff rarely appear in concentrations above Arizona numeric AWQS or EPA primary standards, although this has occurred for antimony, thallium, and beryllium. Concentrations above EPA secondary standards occur occasionally for aluminum, iron, and manganese, and rarely for total dissolved solids.

The overall water quality of the deep groundwater system is more variable than the shallow and Apache Leap Tuff systems, with greater total dissolved solids (median of 410 mg/L) that often can be above the EPA secondary standard. Only one sample (in 2011) exhibited concentrations above AWQS values. Concentrations often are above EPA secondary standards for aluminum, iron, manganese, sulfate, and fluoride. Samples with elevated sulfate, total dissolved solids, iron, and manganese appear to be within the proposed mineralized ore zone (Montgomery and Associates Inc. 2012).

Groundwater is also extracted from Shaft 9 as part of the ongoing dewatering. Groundwater associated with discharge from Shaft 9 has very high sulfate concentrations and, by extension, elevated total dissolved solids. Numerous constituents can be found in concentrations above Arizona numeric AWQS and EPA primary and secondary standards. This sampling location should not, however, be considered representative of the deep groundwater system, as it is affected by historical mine activity. The impacts at this location appear to be influenced by sulfide mineral oxidation, although the solution is routinely near neutral pH.

Age of Groundwater

Chemical characteristics of groundwater (isotopes) that may be used to assess age do not have explicit regulatory standards. Carbon-14 (^{14}C) and tritium have both been measured in shallow system, Apache Leap Tuff aquifer, and deep groundwater system sources to constrain age and provide understanding of water movement. These isotopic measurements indicate that shallow groundwater is typically estimated to be less than 700 years old, whereas Apache Leap Tuff and deep groundwater are 3,000–5,000 and 6,000–15,000 years old, respectively.

Trends in Groundwater Quality

Based on groundwater samples collected roughly between 2003 and 2015, over time the groundwater quality, in terms of major chemical constituents (e.g., calcium, magnesium, bicarbonate, sulfate) has remained generally stable in the shallow groundwater system and Apache Leap Tuff aquifer. The shallow system has displayed the greatest amount of variation, largely confined to variations in sulfate concentration. Although data for deep groundwater show significant variation with location, available data indicate there is little seasonal variability.

EXISTING SURFACE WATER QUALITY

Surface water occurs broadly across the entire project area. The settings in which surface water occurs span a wide range, from small to large drainage areas and channels and with highly variable flow rates. The kinds of surface water present (including springs and perennial streams) are described in further detail in both the “Groundwater Quantity and Groundwater-Dependent Ecosystems” and “Surface Water Quantity” resource sections in this chapter.

Period of Record for Surface Water Quality Data

The surface water baseline monitoring program for the project area was initiated in 2003 and has continued through present, with a 2-year hiatus

in 2006 and 2007. Although surface water data have been collected since 2003, the number of samples collected varies from location to location. Water quality data are available for a total of 47 locations. Through 2015, 505 samples of surface water have been collected and chemically analyzed for 37 water quality parameters.

Most surface water monitoring has been conducted in the Devil's Canyon watershed (main canyon and two tributaries). Queen Creek, along the northern margin of Oak Flat prior to entering the Superior area, has also been extensively characterized (Montgomery and Associates Inc. 2013, 2017d).

Several other sampling locations provide the basis for background water quality in the bypass seepage mixing/loading models. These include Queen Creek at Whitlow Ranch Dam (15 samples between 2017 and 2018), the Gila River below Donnelly Wash (one sample in 2018), and the Gila River below Dripping Spring Wash (one sample in 2018).

Types of Surface Water Quality Data Collected

As with groundwater, all samples were analyzed for a wide range of chemical constituents, including water quality measurements made on water samples in the field at the point of collection (e.g., pH, temperature) and analyses conducted by State-certified analytical laboratories. Some of the constituents analyzed are directly related to water quality, including those that have regulatory standards in the state of Arizona. Other constituents such as isotopes were sampled to help understand groundwater dynamics and the potential for interaction with local surface water resources (Garrett 2018d).

Chemical Quality of Surface Waters

In general, surface water in the area is a calcium-sodium-bicarbonate type, with a neutral to alkaline pH. Based on sampling conducted by Resolution Copper, the basic chemistry of surface water does not vary widely across the project site and does not show any identifiable long-term trends, either increasing or decreasing. For the three principal drainages associated with the project—Devil's Canyon, Queen Creek, and Mineral Creek—water quality is generally considered to be of acceptable quality, although all three have exhibited concentrations above Arizona surface water quality standards at different times for several different constituents (Montgomery and Associates Inc. 2013, 2017d). A summary of the number of surface water samples with concentrations above Arizona numeric surface water standards is included in appendix N, table N-4; the constituents most often noted are arsenic, thallium, copper, lead, and selenium.

Appendix N, table N-2 presents a summary of water quality for defined reaches of the principal drainages, for filtered water samples (dissolved concentrations). Appendix N, table N-3 presents the same types of data for unfiltered samples (total concentrations). A summary of Arizona numeric surface water standards and which bodies they are applicable to is included in appendix N, table N-5. The State of Arizona has conducted more extensive sampling throughout the watershed since 2002–2003, with a focus on identifying sources of pollutants affecting impaired reaches of Queen Creek, Arnett Creek, and several tributary washes. ADEQ found that copper and lead vary across the watershed, with the highest concentrations of copper observed in runoff from Oak Flat and subwatersheds generally north of the West Plant Site. ADEQ also observed variations in runoff hardness (which is important for calculating surface water quality standards) and lead across the watershed (Louis Berger Group Inc. 2013).

Impaired Waters

The objective of the CWA is to restore and maintain the chemical, physical, and biological integrity of the nation's waters. To fulfill this objective, the State of Arizona is required to assess the existing quality of surface waters and identify any water bodies that do not meet State surface water quality standards. Each pollutant (i.e., copper, lead, suspended sediment) is looked at individually.

When a water body is identified that does not meet water quality standards, the next step taken by ADEQ is to develop a total maximum daily load (TMDL) for that pollutant. The TMDL is the amount to of a pollutant that a stream or lake can receive and still meet water

quality standards. The studies to support developing a TMDL look at the point sources (i.e., discharge from municipalities or industries) and nonpoint sources (i.e., stormwater runoff from agriculture or the natural landscape).

Within the Queen Creek, Mineral Creek, and Gila River watersheds, several streams appear on the 303(d) Impaired Waters List (Arizona Department of Environmental Quality 2018a). The most recent list (2018) includes the following streams within the analysis area:

- Queen Creek, from headwaters to Superior Wastewater Treatment Plant discharge. Impaired for dissolved copper (since 2002), total lead (since 2010), and total selenium (since 2012). Two unnamed tributaries to this reach are also impaired for dissolved copper (since 2010).
- Queen Creek, from Superior Wastewater Treatment Plant discharge to Potts Canyon. Impaired for dissolved copper (since 2004).
- Queen Creek, from Potts Canyon to Whitlow Canyon. Impaired for dissolved copper (since 2010).
- Arnett Creek, from headwaters to Queen Creek. Impaired for dissolved copper (since 2010).
- Gila River, from San Pedro River to Mineral Creek. Impaired for suspended sediment (since 2006).

Of these, the only two reaches with the potential to receive additional pollutants caused by the Resolution Copper Project are Queen Creek below the Superior Wastewater Treatment Plant, due to runoff or seepage from Alternatives 2, 3, and 4, and the Gila River from the San Pedro River to Mineral Creek, due to runoff or seepage from Alternative 6.

In investigating the potential sources of copper in the watershed, ADEQ identified that the dominant source of copper to Queen Creek was runoff from the soils and rocks in the watershed, not point source discharges, and was a combination of natural background copper content and historic fallout from copper smelting (Louis Berger Group Inc. 2013). Part of the copper contribution looked at specifically by ADEQ was from Oak Flat. About 20 percent of the runoff reaching Superior would be captured by the subsidence crater and potentially could reduce copper loads to Queen Creek. For the purposes of the EIS, no such reductions are being assumed, in order to ensure that the impacts from copper loads from tailings seepage are not underestimated. Copper loads to Queen Creek due to the Resolution Copper Project are discussed in section 3.7.2.4.

MINE ROCK ANALYSIS

Rock within the proposed subsurface zone of mining is highly mineralized. However, not all the rock that is mineralized is ore grade and identified for proposed recovery. Much mineralized rock would remain in place during, and after mining. This rock contains sulfide minerals (e.g., pyrite, iron disulfide) and other metal-containing material. During mining, and after mining for some time, exposure of these minerals to oxygen could lead to their chemical weathering. This weathering may contribute acidity and metals to contact water and diminish its overall quality. The mine rock has been sampled and analyzed to assess the extent to which it might affect water that accumulates and is removed during mining, as well as the potential effects on groundwater that floods the mine void after mining is completed.

Amount of Geochemistry Tests Conducted

MWH Americas (2013) reports the rock units and alteration types that have been evaluated, and the number of samples for each. This information is summarized in table 3.7.2-4. Overall, 226 samples were submitted for analysis of Tier 1 procedures, with 13 duplicates for a total of 239 samples. A total of 54 samples were identified and submitted for Tier 2 evaluation using humidity cells; these cells were run for periods lasting from 16 to 74 weeks. Saturated column tests were then performed on samples from 14 of the 54 humidity cell tests, and were

Table 3.7.2-4. Rock units, alteration types, and number of samples submitted for Tier 1 geochemical evaluation

Code	**Rock Unit**	**Count**
Tal	Tertiary Apache Leap Tuff (Ignimbrite)	7
Tw	Tertiary Whitetail Conglomerate	11
Kvs	Cretaceous volcanics and sediments (undifferentiated)	101
Kqs	Cretaceous quartz-rich sediments	1
QEP	Quartz eye porphyry; rhyodacite porphyry	37
FP/LP	Felsic porphyry; latite porphyry	3
Dm	Devonian Martin limestone (skarn)	21
Andesite	Andesite	1
Diabase	Diabase	22
Qzite	Quartzite	17
Breccia/Hbx	Heterolithic breccia	3
Fault	Fault	2
	Total	**226**
Code	Alteration Type	**Count**
AA	Advanced argillic	19
ARG	Argillic	1
HFLRET	Retrograde hornfels	5
PHY	Phyllic	111
POT	Potassic	31
PRO	Propylitic	16
SA	Supergene argillic	7
SIL	Siliceous	1
SKN/SKRET	Skarn/Retrograde skarn	16
UNALT	Unaltered	18
ZEO	Zeolite	1
	Total	**226**

run for a 12-week period. Specific Tier 1 and Tier 2 tests are described in the next section

Types of Geochemistry Tests Conducted

Mine rock has been evaluated using a range of established, standard (best practices) methods for the mining industry (International Network for Acid Prevention 2018) as well as those that are regulatorily mandated procedures (Arizona Department of Environmental Quality 2004). These methods assess

- the potential for rock to generate acidic drainage,
- the rate at which such acid generation may occur, and
- what constituents of concern might be released and their associated concentrations.

Specific methods include

- whole rock chemical composition (concentration of wide range of elements),
- acid-base accounting (Sobek et al. 1978),
- net acid generation test (Stewart et al. 2006),
- synthetic precipitation leaching procedure (U.S. Environmental Protection Agency 1994),
- particle size analysis,
- humidity cell testing (American Society for Testing and Materials 1996), and
- saturated column testing (a project-specific test to leach the residual humidity cell testing procedure material.

The first five procedures (whole rock chemical composition, acid-base accounting, net acid generation test, synthetic precipitation leaching procedure, and particle size analysis) are Tier 1 procedures required in the Arizona Best Available Demonstrated Control Technology (BADCT) guidance (Arizona Department of Environmental Quality 2004). The last two are called for in the Tier 2 test-level requirements, which are generally conducted on fewer samples but take place over a longer period of time. Humidity cells are designed to mimic chemical weathering in the laboratory, and assess the rate of acid generation over time, and changes in water quality over time as a sample weathers. Saturated column tests are designed to mimic what would happen when the block-cave zone refloods after mining.

Beyond these chemical testing methods that directly assess potential impacts on the quality of contacting water, mine rock has been evaluated using mineralogical techniques such as

- petrography (microscopic evaluation of mineral grain sizes and contact boundaries),
- X-ray diffraction (identifies actual minerals present and their abundance), and
- scanning electron microscopy (evaluation of mineral formulas and textures).

Geochemical testing fundamentally is meant to determine if a given rock sample is potentially acid generating or not, and if so, to what extent. The geochemical tests indicate that there are numerous rock units associated with the project that have acid generation potential; geochemical tests on simulated tailings samples similarly have demonstrated the potential for acid generation.

Results of Geochemistry Tests – Mine Rock

Acid-base account testing of mine rock indicates that overall, most rock is classified as likely to generate acid rock drainage. ADEQ (2004) provides guidance for using acid-base account measurements to classify mine rock as either acid generating, non-potentially acid generating (NPAG), or potentially acid generating (PAG). To do this, the net neutralizing potential (NNP) is calculated, which is simply the acid

neutralizing potential of the sample minus the acid generating potential of the sample. These prescriptive guidelines (Arizona Department of Environmental Quality 2004) for classifying mine materials use the following definitions:

- If NNP is less than −20, the rock can be considered acid generating.
- If NNP is greater than +20, the rock can generally be considered NPAG.
- Samples that fall between −20 and +20 are considered uncertain and may be tested further using kinetic testing methods.

Table 3.7.2-5 summarizes the percentage of each major rock type, according to hydrothermal alteration type, that is classified as either acid generating, NPAG, or PAG.

Humidity cell testing (a type of kinetic testing) has been conducted for assessing PAG and NPAG material. The kinetic testing is less for identifying the potential for acid generation, but more importantly for estimating specific weathering rates for developing chemical loading terms to be used in the seepage modeling. Humidity cell testing confirmed that samples identified as PAG in Tier 1 testing continued to produce acid leachates over time.

Results of Geochemistry Tests – Tailings

Tailings samples have been produced as part of metallurgical processing investigations and have been characterized for the potential to produce acid. Tailings would be produced in a such a way that part of the production stream would be highly enriched in acid-generating pyrite (the PAG tailings), and the balance would be depleted in pyrite as a result (the NPAG tailings). As summarized by Duke HydroChem LLC (2016), and reported in table 3.7.2-6, as would be expected all the PAG tailings are classified as acid-generating, whereas NPAG tailings are roughly equal parts non-acid generating and potentially acid generating, with a small percentage considered acid generating.

3.7.2.4 Environmental Consequences of Implementation of the Proposed Mine Plan and Alternatives

No Action Alternative

Under the no action alternative, seepage would not develop from a tailings facility and contribute to chemical loading in downgradient aquifers or surface waters, and stormwater would not potentially contact tailings, ore, or process areas. Water quality in the block-cave zone and surrounding aquifers would continue to match current conditions.

Impacts Common to All Action Alternatives

EFFECTS OF THE LAND EXCHANGE

The land exchange would have effects on groundwater and surface water quality.

The Oak Flat Federal Parcel would leave Forest Service jurisdiction. The role of the Tonto National Forest under its primary authorities in the Organic Administration Act, Locatable Regulations (36 CFR 228 Subpart A), and Multiple-Use Mining Act is to ensure that mining activities minimize adverse environmental effects on NFS surface resources; this includes water quality. The removal of the Oak Flat Federal Parcel from Forest Service jurisdiction negates the ability of the Tonto National Forest to regulate effects on these resources.

The offered lands parcels would enter either Forest Service or BLM jurisdiction. A number of perennial water features are located on these lands and entering Federal management would offer additional protection for the water quality of these resources.

FOREST PLAN AMENDMENT

The Tonto National Forest Land and Resource Management Plan (1985b) provides guidance for management of lands and activities within the Tonto National Forest. It accomplishes this by establishing

Table 3.7.2-5. Acid-generating ion classification of mine rock samples based on geological unit and alteration type

Geological Unit*	Alteration Type	Acid Generating	Non-acid Generating	Potentially Acid Generating
Andesite	Potassic	0.0%	0.0%	100.0%
Breccia	Advanced Argillic	100.0%	0.0%	0.0%
Breccia	Phyllic	50.0%	50.0%	0.0%
Diabase	Phyllic	100.0%	0.0%	0.0%
Diabase	Potassic	73.7%	0.0%	26.3%
Martin limestone	Retrograde Hornfels	16.7%	83.3%	0.0%
Martin limestone	Skarn	40.0%	53.3%	6.7%
Cretaceous volcanics & sediments (undifferentiated)	Advanced Argillic	36.4%	45.5%	18.2%
Cretaceous volcanics & sediments (undifferentiated)	Phyllic	70.8%	12.3%	16.9%
Cretaceous volcanics & sediments (undifferentiated)	Propylitic	85.7%	0.0%	14.3%
Quartz eye porphyry	Advanced Argillic	100.0%	0.0%	0.0%
Quartz eye porphyry	Phyllic	75.0%	12.5%	12.5%
Quartz eye porphyry	Potassic	75.0%	25.0%	0.0%
Quartz eye porphyry	Siliceous	100.0%	0.0%	0.0%
Quartzite	Advanced Argillic	100.0%	0.0%	0.0%
Quartzite	Phyllic	100.0%	0.0%	0.0%
Quartzite	Zeolite	100.0%	0.0%	0.0%
Apache Leap Tuff	Unaltered	0.0%	83.3%	16.7%
Overall		**63.7%**	**22.4%**	**13.9%**

* The percentage of the ore body of each rock type are generally: diabase (30%); quartzite (11%); quartz eye porphyry (15%); breccia (19%); Cretaceous volcanics and sediments (26%); Apache Leap Tuff (0%) (see Garrett (2017b)).

Table 3.7.2-6. Acid-generation classification of tailings samples

Tailings Type	Acid Generating	Non-acid Generating	Potentially Acid Generating
NPAG tailings (84% of total amount)	15%	41%	44%
PAG tailings (16% of total amount)	100%	0%	0%

a mission, goals, objectives, and standards and guidelines. Missions, goals, and objectives are applicable on a forest-wide basis. Standards and guidelines are either applicable on a forest-wide basis or by specific management area.

A review of all components of the 1985 forest plan was conducted to identify the need for amendment due to the effects of the project, including both the land exchange and the proposed mine plan (Shin 2019). A number of standards and guidelines (16) were identified applicable to management of water resources. None of these standards and guidelines were found to require amendment to the proposed project, either on a forest-wide or management area-specific basis. For additional details on specific rationale, see Shin (2019).

SUMMARY OF APPLICANT-COMMITTED ENVIRONMENTAL PROTECTION MEASURES

A number of environmental protection measures are incorporated into the design of the project that would act to reduce potential impacts on groundwater and surface water quality. These are non-discretionary measures and their effects are accounted for in the analysis of environmental consequences.

- Stormwater controls (described in detail in "Potential Surface Water Quality Impacts from Stormwater Runoff")
- Engineered seepage controls (described in detail under each alternative in "Potential Water Quality Impacts from Tailings Storage Facility")

POTENTIAL GROUNDWATER QUALITY IMPACTS WITHIN BLOCK-CAVE ZONE

Predicted Block-Cave Water Quality at Closure

The water quality in the block-cave sump at the end of active mining was modeled using the block-cave geochemistry model (Eary 2018f), as shown previously in table 3.7.2-1. At the end of mine life, no constituents in the block-cave sump are anticipated to have concentrations above Arizona numeric AWQS except for thallium. Several constituents are anticipated to have concentrations above EPA secondary standards, including aluminum, fluoride, sulfate, and total dissolved solids, and arsenic is anticipated to be above the EPA primary standard (which is lower than the Arizona numeric AWQS).

Post-Closure Trends in Block-Cave Water Quality

Even if ventilation assumptions used in Eary (2018f) bear out during operations, weathering products may accumulate on collapsed, mineralized rock in the block cave during mining due to the exposure to humid air and oxygen. If the oxygenated conditions of Hatch (2016) predominate, some of these products would dissolve in downward-migrating Apache Leap Tuff groundwater. Some can, however, be expected to be retained on unrinsed rock. These products would be dissolved in water that floods the block cave post-mining. Because these products are not associated with the block-cave water quality model, their release to reflooding waters would increase the concentration of chemical constituents and the water quality would worsen over time, potentially resulting in concentrations of metals (antimony, beryllium, cadmium, chromium, lead, nickel, selenium, thallium) above Arizona aquifer water quality standards, as shown in table 3.7.2-1.

Potential for Subsidence Lake Development

The Groundwater Modeling Workgroup recognized that three simultaneous events would take place that suggest there could be the potential for the creation of a surface lake on Oak Flat after closure of the mine:

- The subsidence crater would develop. The base case model run indicates the subsidence crater would be about 800 feet deep. Most of the sensitivity runs of the subsidence model are similar, although one sensitivity model run reached about 1,100 feet deep (Garza-Cruz and Pierce 2018).

Table 3.7.2-7. Comparison of rebounding groundwater levels and subsidence crater elevation

Well	Current Land Surface Elevation (from well schematics)	Estimated Elevation of Bottom of Subsidence Crater (based on a total crater depth of 800–1,100 feet)	Estimated Water Level Elevation at End of Mining	Estimated Water Level Elevation After 1,000 Years	Elevation of MSD One Portal	Elevation of Never Sweat Tunnel	Elevation of Umbrella Cave
DHRES-01	4,076	3,276–2,976	−2,799	2,666	2,930	3,200	2,992
DHRES-02	3,976	3,176–2,876	−2,798	2,666	2,930	3,200	2,992
DHRES-08	4,120	3,320–3,020	−2,798	2,666	2,930	3,200	2,992

Note: All elevations are given in feet above mean sea level (amsl).

- Groundwater levels would rebound and rise as the aquifer equilibrates after dewatering is curtailed after closure of the mine.
- Block-caving would have created a hydraulic connection from the surface to the deep groundwater system and eliminated any intervening layers like the Whitetail Conglomerate that formerly were able to prevent or slow vertical groundwater flow.

The Groundwater Modeling Workgroup explored the potential for a subsidence lake to form. Ultimately the Forest Service determined that the presence of a subsidence lake was speculative and not reasonably foreseeable, and as such it would therefore be inappropriate to analyze in the EIS. For a subsidence lake to form, groundwater levels would have to rebound to an elevation greater than the bottom of the subsidence crater. Table 3.7.2-7 summarizes the modeled groundwater levels for the three wells within the area of the subsidence crater. The best-calibrated model indicates that after 1,000 years, groundwater levels are still at least 200 feet below the bottom of the subsidence crater, and possibly as much as 650 feet below the bottom of the subsidence crater. Relative positions of the subsidence crater and recovering groundwater levels are shown in figure 3.7.2-4.

Potential for Other Exposure Pathways for Block-Cave Groundwater

The Groundwater Modeling Workgroup explored the potential for exposure to block-cave groundwater at the surface other than through a subsidence lake. The Magma Mine workings connect the block-cave area to the ground surface, and questions arose if the historic workings of the Magma Mine could be a pathway for block-cave groundwater to emerge at the surface. There is also at least one natural cave in the area (Umbrella Cave) that could represent an exposure pathway. Elevations for possible exposure points are shown in table 3.7.2-7.

Ultimately the group determined that block-cave groundwater would not rise to an elevation that would allow it to daylight through the Magma Mine workings, and thus there would be little potential for exposure to block-cave groundwater. The Groundwater Modeling Workgroup determined this based on the following rationale:

- During operations, pumping would dewater the Magma Mine workings. After dewatering ends, collected water in the Magma Mine workings would drain toward the block-cave zone, and not outward.
- The Magma Mine portal that comes to surface at the lowest elevation (MSD One Portal) daylights at an elevation of 2,930 feet amsl. At 1,000 years, this remains over 260 feet above recovered groundwater levels.

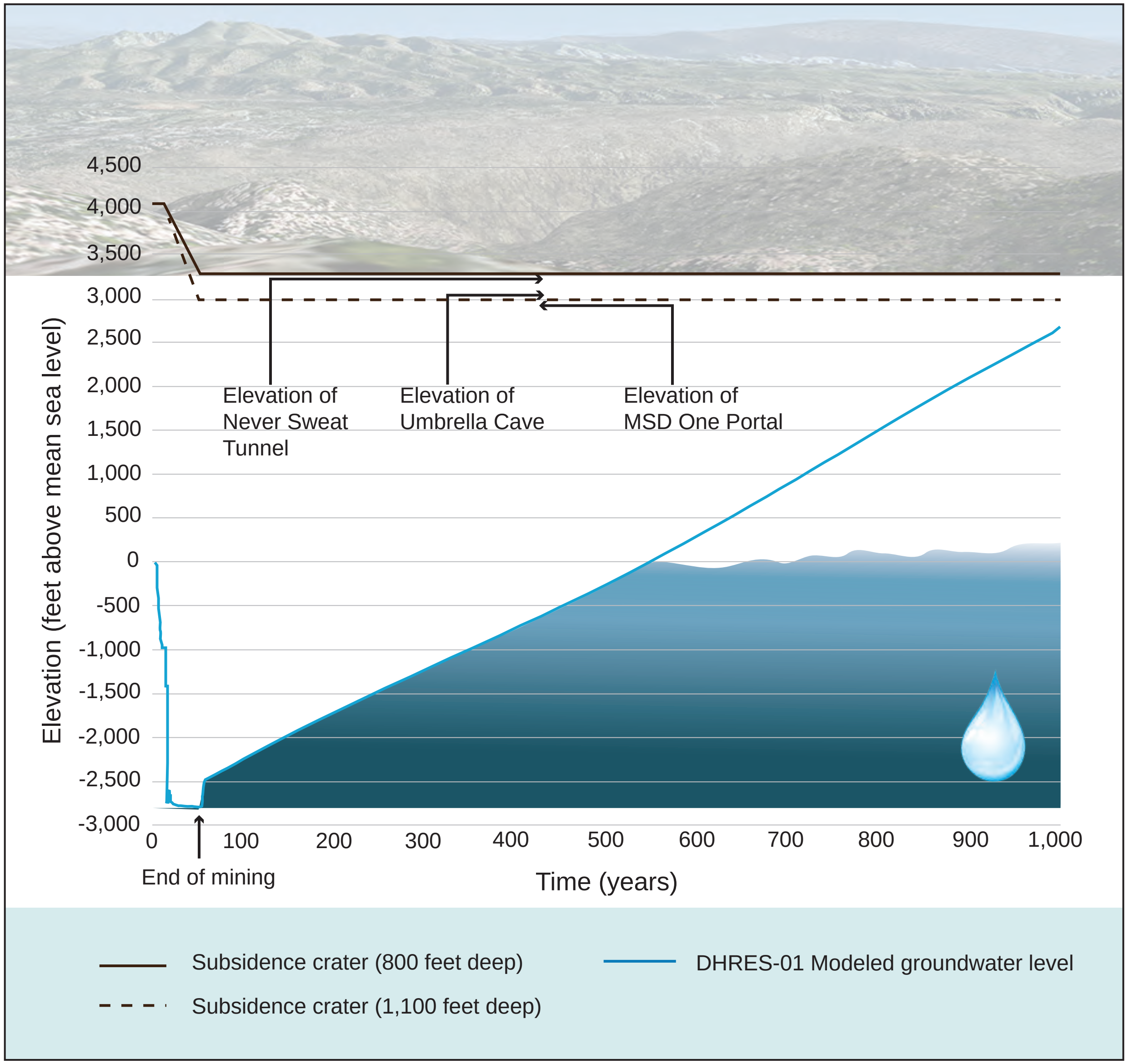


Figure 3.7.2-4. Potential for subsidence lake and other points of exposure of block-cave water

Table 3.7.2-8. Representative values of possible subsidence lake water sources (mg/L)

Constituent	Apache Leap Tuff Groundwater (see appendix N)	Deep Groundwater (see appendix N)	Block-Cave Sump Geochemistry at Closure (see table 3.7.2-1)	Precipitation*	Surface Water Quality Standard†
Total dissolved solids	248	638	1,528	10–20	–
Sulfate	18	252	934–2,247	2.2	–
Antimony	Non-detect	0.01	0.0047–0.035	Non-detect	0.030
Cadmium	Non-detect	Non-detect	0.0008–0.19	Non-detect	0.00068–0.0062
Selenium	Non-detect	Non-detect	0.0051–0.5	Non-detect	0.002
Copper	0.01	0.10	0.0148–141	Non-detect	0.0023–0.0293
Nitrate	0.52	0.43	Not modeled	0.27–1.05	–
Hardness (as $CaCO_3$)	126	335	851–1,690	4	–

* Carroll (1962); Root et al. (2004); metal loads in precipitation are assumed to be insignificant for comparison

† For comparison, the standard for Aquatic and Wildlife-Warmwater, chronic exposure is shown. Where hardness is required to calculate the standard, a range is shown. Antimony, cadmium, and copper standards are for dissolved concentrations, selenium is for total concentrations. Model data are not specific to total or dissolved fractions; for the purposes of comparison to surface water standards it can be assumed to apply to both.

- A tunnel that drains away from the block-cave zone (Never Sweat Tunnel) intercepts the subsidence crater at approximately 3,200 feet amsl. At 1,000 years, this remains over 530 feet above recovered groundwater levels.
- Umbrella Cave has an elevation of 2,992 feet amsl and remains over 320 feet above recovered groundwater levels at 1,000 years.
- The cone of depression in the aquifer created by the mine dewatering would persist for hundreds of years, creating hydraulic conditions that prevent subsurface flow away from the block-cave area.

The relative positions of the subsidence crater, other potential exposure points, and the modeled rise of groundwater levels is shown in figure 3.7.2-4.

Possible Water Quality Outcomes from a Subsidence Lake

While the fundamental processes needed to create a subsidence lake are reasonably foreseeable—rebounding water levels, subsiding ground surface, fracturing of intervening geological layers—the relative elevations based on the modeling conducted does not support that these processes would come together in a way that would actually create a lake within the subsidence crater.

Similarly, if a lake developed, it is not possible to predict the details that would be necessary to conduct even a rudimentary analysis of effects. For instance, the depth of the lake cannot be known with any accuracy. That single parameter would affect both the amount of inflow of native groundwater and the amount of evaporation that would occur from the lake surface, and it is the interplay of these two parameters that largely determines how constituents would concentrate in the lake and whether the ultimate water quality would be hazardous to wildlife.

Formation of a lake is speculative, but some context can be provided for the possible water quality in the subsidence lake. Water quality for

the basic inputs is generally known, even if the relative amounts, how they would mix, and what evaporation would take place are not known. Representative values are shown in table 3.7.2-8, with comparison to Arizona surface water standards for wildlife. The broad conclusion that can be drawn is that if a subsidence lake were to form, a potential exists for concentrations above Arizona surface water standards, particularly copper. However, the potential also exists for water quality to be acceptable. These represent the bounds of possible outcomes.

POTENTIAL SURFACE WATER QUALITY IMPACTS FROM STORMWATER RUNOFF

Stormwater Controls and Potential for Discharge of Stormwater

Construction and Operation Phases

Stormwater control measures for each alternative are described in Newell and Garrett (2018d). During construction, temporary sediment and erosion controls would be implemented as required under a stormwater permit issued by ADEQ. These controls would include physical control structures as well as best management practices. Physical control structures could include diversions, berms, sediment traps, detention basins, silt fences, or straw wattles. Best management practices could include limiting vegetation removal, good housekeeping, proper material storage, and limiting ground disturbance. Stormwater control measures are generally kept in place until disturbed areas are stabilized either through revegetation or by permanent constructed facilities.

Generally speaking, during operations any precipitation or runoff that comes into contact with tailings, ore, hazardous material storage areas, or processing areas is considered "contact water." During operations contact water would be captured, contained in basins, pumped out after storm events, and recycled back into the process water stream. This type of containment would be required by both the stormwater and aquifer protection permits that would be issued for the project. Contact water would not be released to the environment at any time during operations.

There are areas of the West Plant Site and filter plant and loadout facility that are undisturbed or contain only ancillary facilities. Stormwater from these areas is considered "non-contact" stormwater. In many cases, upstream runoff would be diverted around the project facilities to prevent the stormwater from becoming contact water and would be allowed to continue flowing into downstream drainages. Non-contact stormwater would be allowed to leave the property.

The tailings storage facility generally follows the same strategy during operations. For all alternatives, runoff from upstream of the facility would be diverted around the facility to prevent any contact with tailings. For Alternatives 2, 3, 5, and 6, any precipitation falling within the facility would run into the recycled water pond, and any runoff from the external embankments would be routed to the downstream seepage collection ponds, then pumped back and recycled into the process water stream. For Alternative 4, with filtered tailings, the tailings surface is designed to minimize ponding, and all contact water would be routed to downstream seepage collection ponds. As with the other alternatives, the water from the Alternative 4 seepage collection ponds would be pumped back and recycled in the process water stream; however, with Alternative 4, the water quality running off of the PAG tailings facility may be such that it requires further treatment prior to reuse.

Closure and Post-closure Phases

With respect to stormwater, the goal upon closure is to stabilize disturbed areas, minimize long-term active management, and return as much flow as possible to the environment. This is readily accomplished at the East Plant Site, West Plant Site, and filter plant and loadout facility once facilities are demolished and removed, and the sites are revegetated. Closure details for these areas are included in sections 6.5, 6.6, 6.8, and appendix Y of the GPO (Resolution Copper 2016d).

The tailings storage facility represents a more complex closure problem, regardless of alternative. The specific goals of closing the tailings storage facility are as follows:

- Develop a stable landform
- Develop a stable vegetated cover that limits infiltration and protects surface water quality by preventing contact of stormwater with tailings
- Minimize ponded water on the closed tailings surface
- Limit access of oxygen to PAG tailings to prevent oxidation of pyrite materials (acid rock drainage)
- Protect the reclaimed surface against wind or water erosion
- Provide a growth medium for vegetation to establish and be sustained in perpetuity

Closure of the tailings facilities for Alternatives 2, 3, 5, and 6 is a long-term phased process that involves gradually reducing the size of the recycled water pond and then encapsulating the PAG tailings with NPAG tailings. Eventually the tailings embankments and top surface of the facility are given a soil cover with a thickness of at least 1 to 2 feet and revegetated. Stormwater conveyance channels and armoring would be used where appropriate to protect the reclaimed surface. Once surfaces are covered and stable, stormwater could be allowed to discharge downstream if water quality meets release criteria.

For some time after closure, the seepage collection ponds would be maintained downstream of the tailings storage facility to collect drainage from the facility. This time could vary from years to decades, depending on the alternative. There would be no discharge from the collection ponds to downstream waters, neither seepage nor stormwater that collects within the ponds. For some time the recycled water pond would still exist within the tailings facility, and during this time collected water in the seepage ponds could be pumped back to the recycled water pond for evaporation. Once the recycled water pond disappears, the seepage collection ponds are designed to be large enough to evaporate any collected seepage and stormwater. The seepage collection ponds are meant to stay in place until all water reporting to the ponds is of adequate quality to allow discharge downstream.

Closure of the filtered tailings facility (Alternative 4) is similar but simplified by the lack of any recycled water pond. Instead, all surfaces of the PAG and NPAG facilities would be given a soil cover and revegetated. Stormwater from upstream in the watershed would be diverted around the facilities in perpetuity, and once surfaces are covered and stable, stormwater from the facilities could be allowed to discharge downstream as well if water quality meets release criteria.

For some time after closure (estimated to be about 5 years), the seepage collection ponds for Alternative 4 would be maintained downstream of the tailings storage facility. The seepage collection ponds are meant to stay in place until all water reporting to the ponds is of adequate quality to allow discharge downstream. Unlike Alternatives 2, 3, 5, and 6, any excess water in the seepage collection ponds during closure cannot be pumped back to a recycled water pond; these ponds therefore could require active water treatment. In the long term, the ponds are designed to be large enough to evaporate any collected seepage and stormwater.

The potential for ponds to impact wildlife is assessed in section 3.8.4.2.

Summary of Stormwater Controls

At no point during construction, operation, closure, or post-closure would stormwater coming into contact with tailings, ore, or processing areas be allowed to discharge downstream. After closure, precipitation falling on the tailings facilities would interact with the soil cover, not tailings. The seepage collection ponds represent a long-term commitment for managing seepage and stormwater, but eventually would either become passive systems fully evaporating collected water, or would be removed after demonstrating that collected water is of adequate quality to discharge.

Stormwater mixes with collected seepage in collection ponds and some would be lost to the environment; this occurrence is incorporated into the bypass seepage mixing/loading model.

Predicted Quality of Stormwater Runoff

Stormwater contacting tailing would not be released downstream; however, the potential water quality of this runoff has been estimated.

The quality of stormwater runoff from tailings and the soil cover can be predicted in several ways. In the aquifer protection permitting process, ADEQ often relies on a test called the synthetic precipitate leaching procedure (SPLP). This test measures contaminants in a slightly acidic water solution that has interacted with a rock or tailings sample. One drawback of relying solely on the SPLP test is that it is usually conducted only using fresh core or lab-created tailings samples that have not weathered. By contrast, in reality, precipitation could interact with embankment tailings that could have been weathering for years or decades.

Two additional methods reflect the water quality from interaction with weathered materials. As part of the geochemical characterization activities, Resolution Copper conducted a series of "barrel" tests, in which barrels of material were left exposed to natural precipitation over the course of several years. The resulting leachate from the barrels was periodically collected and analyzed. Numerous humidity cell tests also were run for long periods of time. These tests involve periodic exposure of samples to water over many weeks, even years. An estimate of the potential runoff water quality from PAG and NPAG tailings was produced, drawing on the results of these various geochemical tests (Eary 2018g). Runoff from NPAG tailings was calculated by combining the results of 12 humidity cell tests conducted on tailings samples representing different lithologies. Potential runoff water quality from PAG tailings (applicable to Alternative 4 only) was estimated from barrel tests conducted on filtered PAG tailings (specifically Barrel #3), supplemented with results from barrel tests conducted on paste PAG tailings (specifically Barrel #1).

Resolution Copper also sampled natural runoff quality, specifically during a storm event in February 2018 in the vicinity of the Near West location (specific to Alternatives 2 and 3).

Water quality results for SPLP tests, Resolution Copper estimates of runoff quality, and natural runoff are shown in table 3.7.2-9 and compared with the surface water quality standards for the most restrictive use.[49]

All methods of estimating stormwater runoff quality suggest that both NPAG and PAG tailings may have concentrations of some constituents that are above Arizona surface water standards. As stated above, this stormwater would not be discharged to the environment at any time; the results shown in table 3.7.2-9 reinforce the need for requiring stormwater controls during operations. Post-closure runoff water quality, after the soil cover is in place and revegetated, should be similar to natural runoff water quality and concentrations above surface water quality standards would not be anticipated.

Alternative 2 – Near West Proposed Action

POTENTIAL WATER QUALITY IMPACTS FROM TAILINGS STORAGE FACILITY

Seepage Controls Incorporated into Design

A tailings storage facility creates seepage. Total seepage is all water that drains from the tailings storage facility by gravity. Lost seepage is seepage that is not recovered with the engineered seepage controls. Lost seepage is assumed to discharge to the environment.

The design of engineered seepage controls for each alternative has been approached in stages. For Alternatives 2 and 3:

49. Surface water quality standards are difficult to succinctly summarize, as the standards vary by specific designated use of the water body and in some cases vary by hardness of the water. For reference, table N-5 in appendix N summarizes all surface water standards for water bodies in the area, as well as aquifer water quality standards.

Table 3.7.2-9. Predicted stormwater runoff water quality (mg/L)

	Estimated Runoff Water Quality from NPAG Tailings (Alternatives 2, 3, 5, 6)*	Estimated Runoff Water Quality from PAG Tailings (Alternative 4)*	Water Quality Measured in Natural Runoff†	SPLP Results for NPAG Tailings‡	SPLP Results for PAG Tailings‡	Surface Water Standard for Most Restrictive Use (Gila River or Queen Creek)	Surface Water Standard for Most Restrictive Use (Ephemeral Tributaries)
Regulated Constituents							
Antimony	0.00073	0.00062	0.00027	0.003	0.003	0.030	0.747
Arsenic	0.00016	**0.576**	0.0052			0.030	0.280
Barium	0.0128	0.208	0.0128	0.0122	0.0275	98	98
Beryllium	0.0022	**0.192**	0.0005	0.002	0.002	0.0053	1.867
Boron	0.0028	0.104	0.03			1	186.667
Cadmium	0.00097	**0.106**	0.000019	0.0002	0.0002	0.0043	0.2175
Chromium, Total	0.00036	**9.107**	0.00095	0.006	0.006	1	–
Copper	**9.81**	**3,294**	0.012	0.01	0.01	0.0191	0.0669
Fluoride	0	**424.6**	0.13			140	140
Iron	0.177	**5,353.8**	0.0225	0.06	0.06	1	–
Lead	0.00026	**0.0095**	0.0001	**0.0115**	0.003	0.0065	0.015
Manganese	0.693	**43**	0.017	0.0106	0.0313	10	130.667
Mercury				**0.0002**	**0.0002**	0.00001	0.005
Nickel	**0.112**	**26.39**	0.0013			0.1098	10.7379
Nitrate	0	0	3.1			3733.333	3733.333
Nitrite						233.333	233.333
Selenium	**0.0088**	**0.322**	0.00027	**0.003**	0.0043	0.002	0.033
Silver	0.000006	**1.78**	0.000018	0.005	0.005	0.0147	0.0221
Thallium	0.00008	**0.0177**	0.000015	0.001	0.001	0.0072	0.075
Uranium				0.001	0.001	2.8	2.8
Zinc	0.171	**17.29**	**0.0015**	**0.01**	0.01	0.2477	2.8758
pH	**5.48**	**2.13**	7.59	6.53	6.72	**6.5–9.0**	**6.5–9.0**

continued

Table 3.7.2-9. Predicted stormwater runoff water quality (mg/L) *(cont'd)*

	Estimated Runoff Water Quality from NPAG Tailings (Alternatives 2, 3, 5, 6)*	**Estimated Runoff Water Quality from PAG Tailings (Alternative 4)***	**Water Quality Measured in Natural Runoff†**	**SPLP Results for NPAG Tailings‡**	**SPLP Results for PAG Tailings‡**	**Surface Water Standard for Most Restrictive Use (Gila River or Queen Creek)**	**Surface Water Standard for Most Restrictive Use (Ephemeral Tributaries)**
Constituents without Numeric Standards							
Sulfate	264	28,452	6.8	229	115	–	–
Total Dissolved Solids	–	–	–	294	186	–	–

Notes:

See appendix N, table N-5, for details regarding the water quality standards used in this table.

All values shown in milligrams per liter. Shaded cell and bolded text indicate concentrations above at least one water quality standard.

For all analyses, values below the laboratory detection limit are calculated as equal to the detection limit. There are other valid methods that could be used, such as using a zero value, or more commonly, using half the detection limit. Because surface water standards for some constituents—particularly mercury—can be extremely low, it is important to use the detection limit when looking at non-detect results. To use any lower value could yield results that meet the water quality standard, even when the detection limit was actually too high to draw this conclusion.

Some water quality standards for metals are specific to total recoverable metals or dissolved metals. Predicted results are compared with standards regardless of whether the standard specifies total or dissolved.

* From Enchemica, Common Inputs Memorandum, 7/18/18, table 3-4 (Eary 2018g).

† From Enchemica, Common Inputs Memorandum, 7/18/18, table 3-2; from stormwater samples collected at Near West location (Eary 2018g).

‡ NPAG results taken from “7/7A 7C Scavenger” sample from Verberg and Harvey (2008); PAG results taken from “7/7A 7C Cleaner” sample from Verberg and Harvey (2008)

- Level 0: Controls that are inherent in the design of the embankment itself and required for stability, but also function to control seepage.
- Level 1: A suite of engineered seepage controls always envisioned to be part of the design, that served as the starting point for the seepage modeling.
- Levels 2–4: These represent additional layers of engineered seepage control considered during the design process in order to reduce seepage to meet water quality objectives. Some of these controls would have to be built into the facility from the start, such as low-permeability liners for the PAG tailings. Others are expected to be necessary but can be implemented if real-world observations indicate existing seepage controls are not sufficient, such as downstream grout curtains and additional seepage collection ponds.

The following describes the various engineered seepage controls assessed in the Alternative 2 alternative design, and table 3.7.2-10 summarizes how these are expected to be applied. A conceptual diagram of the seepage controls is shown in figure 3.7.2-5. The initial suite of engineered seepage controls includes blanket and finger drains, foundation treatment, and downstream seepage collection dams and pumpback wells.

- Primary seepage control measures for stability (Level 0) include blanket and finger drains built into the facility. Sand and gravel blanket drains are required beneath the cyclone sand embankment; the blanket drain was modeled as a 3-foot-thick, highly conductive layer consisting of coarse gravel that drains the embankment and conveys seepage to the seepage collection ponds downstream of the facility. Finger drains would also collect water from beneath the tailings and convey it beneath the starter dam via a series of lined channels to the seepage collection ponds. Finger drains were modeled as channels 10 feet thick by 30 feet wide, and filled with highly conductive coarse gravel, following the topography of the existing alluvial tributaries.
    - Enhancements: For Level 1 controls, the blanket drain was expanded further beneath the facility to increase seepage control, ultimately extending 200 feet upstream.
- The foundation would be treated during construction to reduce seepage and encourage flow into the drain system. Foundation treatment can include a variety of techniques such as dental concrete,[50] cut-offs, grouting, or engineered low-permeability layers such as compacted fine tailings, engineered low-permeability liners, asphalt, slurry bentonite, and/or cemented paste tailings. Specific treatments would be designed based on real-world conditions encountered during site preparation. For the purposes of the alternative design, it is assumed that engineered low-permeability layers would be used with geological units with relatively higher conductivities (Tertiary perlite, Tertiary tuff, and Precambrian Apache Group units) that underlie approximately one-third of the tailings footprint.
    - Enhancements: For Level 1 controls, the full starter PAG cell was assumed to be underlain by an engineered low-permeability layer. For Level 4 controls, this was expanded to the entire PAG cell.
- Eleven primary seepage collection dams with associated seepage collection ponds would be constructed in natural valleys downstream of the cycloned sand embankment. All alluvial soil underneath the crest of the seepage collection dams would be excavated until competent foundation material is reached. Dams are then covered on the upstream side with an engineered low-permeability layer and built with grouted cut-off walls to help intercept subsurface flow. Pumpback wells would be installed upstream of the grout curtain and would return seepage to the recycled water pond.

50. ”Dental concrete” is conventional concrete that is used to shape surfaces and fill irregularities, much like filling a cavity in a tooth.

Table 3.7.2-10. Effectiveness of Alternative 2 engineered seepage controls

Seepage Control Levels and Components	Uncaptured Seepage from Facility	Source
Uncontrolled seepage from tailings facility	2,132 acre-feet/year	Groenendyk and Bayley (2018b) and Klohn Crippen Berger Ltd. (2018a)
Level 0 (seepage controls for geotechnical stability)		
- Modified centerline cyclone sand embankment - Blanket drain under embankment; finger drains	Not explicitly modeled; incorporated into Level 1 modeling	
Level 0–1		
- Blanket drain extends into facility under NPAG beach; finger drains (blanket/finger drains account for roughly 88% of seepage collected) - Seepage collection ponds with pumpback wells and cut-off walls	194 acre-feet/year	Groenendyk and Bayley (2018a)
Level 1		
- Blanket drain extends 200-feet into facility - Foundation treatment and selected areas of engineered low-permeability layers, for all areas not Gila Conglomerate - Engineered low-permeability layer for starter PAG facility - Seepage collection ponds with pumpback wells, cut-off walls, and grout curtain to 100-foot depth	Not explicitly modeled; incorporated into Level 4 modeling	N/A
Level 2		
- Grout curtain extended to target high-permeability zones and seepage pathways	Not explicitly modeled; incorporated into Level 4 modeling	N/A
Level 3		
- Add second perimeter of seepage collection ponds downstream	Not explicitly modeled; incorporated into Level 4 modeling	N/A
Level 4 (includes Levels 0 through 4)		
- Add pumpback wells, cut-off walls, and grout curtains to second perimeter of seepage collection ponds - Engineered low-permeability layer for entire PAG cell - Downgradient grout curtain extending to 100-foot depth - Additional pumpback wells in targeted areas to maximize capture	20.7 acre-feet/year†	Groenendyk and Bayley (2019)
- For comparison: fully lined facility (3,300 acres)*	792 acre-feet/year	Rowe (2012)

* See Newell and Garrett (2018d) for details of calculations; assumes 1 foot of head over liner.

† Initial estimate of post-closure seepage based on infiltration of precipitation was 17 acre-feet per year; post-closure seepage was later changed to match operational seepage of 20.7 acre-feet per year.

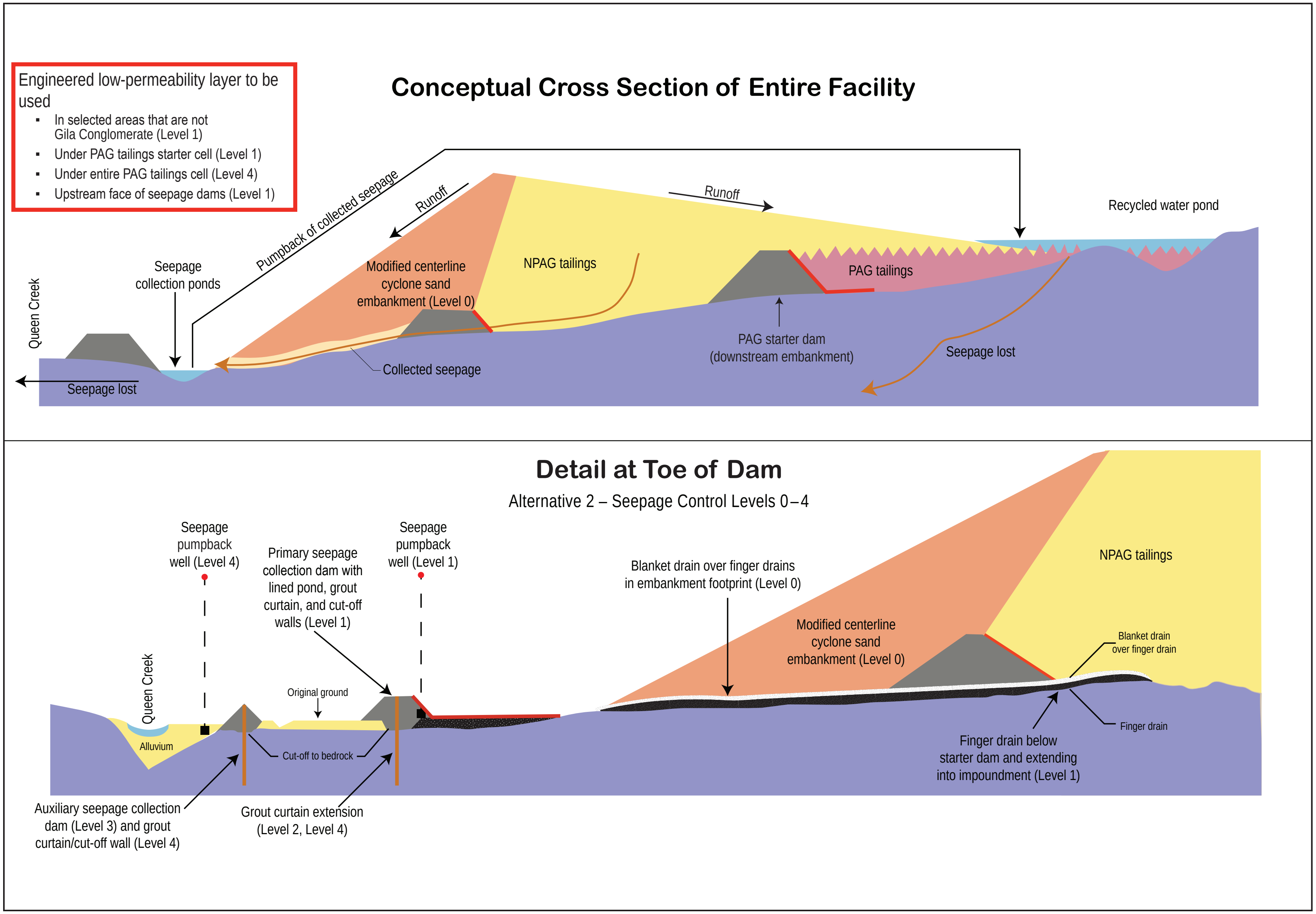


Figure 3.7.2-5. Alternative 2 seepage controls

    - Enhancements: Under Level 1 controls, grout curtains were expanded to 100-foot depth. Under Level 2 controls, grout curtains were expanded to the bedrock ridges between seepage collection dams and any high-permeability zones.

In addition to the basic suite of engineered controls, three additional concepts were brought into the design for further seepage control:

- Five auxiliary seepage collection dams would be constructed downstream of the primary seepage collection dams (Level 3). These could be further enhanced with pumpback wells, cut-off walls, and grout curtains (Level 4).
- A 7.5-mile-long and 100-foot-deep grout curtain would be installed downgradient of the tailings facility (Level 4).
- Twenty-one auxiliary pumpback wells would be installed beyond the grout curtain with depths of approximately 200 feet, wherever deemed useful (Level 4).

Anticipated Effectiveness of Seepage Controls

Total seepage was estimated during the initial design phase using a one-dimensional, unsaturated flow model (Klohn Crippen Berger Ltd. 2018a). Total seepage estimates start with a water balance calculation of flow through the tailings during full buildout, based on assumptions about weather (precipitation and evaporation), consolidation, and area and depth of the tailings.

A three-dimensional groundwater flow model was then used to model the amount of this total seepage that would be captured by various engineered seepage controls, leaving some amount of lost seepage to enter the environment downgradient (Groenendyk and Bayley 2018b, 2019).

During operations, total seepage created by the tailings was estimated at 2,132 acre-feet per year (1,912 and 220 acre-feet per year of NPAG and PAG seepage, respectively) and lost seepage was modeled to be 194 acre-feet per year with Level 1 seepage controls, and 21 acre-feet per year with all enhanced engineered seepage controls (Level 4).

Modeling indicates the Level 4 seepage controls would reach a seepage capture efficiency of 99 percent. Most of this seepage is captured by blanket and finger drains (88 percent).

Risk of Seepage Impacting Groundwater or Surface Water Quality

Modeled results for groundwater and surface water impacts are reported by Gregory and Bayley (2019). The detailed results of the bypass seepage mixing/loading model were supplied as an Excel spreadsheet, and can be found in Garrett (2019c). Table 3.7.2-11 presents model results for all modeled chemical constituents in the first groundwater cell along Queen Creek (cell QC-3)[51] and the ultimate, final surface water cell (Queen Creek at Whitlow Ranch Dam), for model years 41, 100, and 245.[52] This provides perspective on trends and expected conditions at the end of mining and in the long term. Table 3.7.2-11 also presents Arizona water quality standards and baseline chemistry for added perspective.

Figures M-1 through M-7 in appendix M illustrate model results for seven chemical constituents of concern that either are regulated constituents that helped drive the required level of engineered seepage controls incorporated into the design (cadmium, selenium, antimony, copper) or offer other significant perspective on water quality (nitrate,

51. Results are included in the modeling for several washes that would receive lost seepage (Potts and Roblas Canyon), which are upgradient from cell QC-3. It is not likely that substantial groundwater exists in these alluvial channels; these modeled results are indicative of seepage itself, rather than groundwater concentrations expected in the aquifer.

52. Note that model year 41 represents the end of mining, the end of tailings production, and the start of facility closure.

Table 3.7.2-11. Seepage water quality modeling results for Alternative 2 (mg/L)

	Aquifer Water Quality Standard	Baseline Groundwater Quality (Well DS17-17*)	QC-3 Model Cell Year 41	QC-3 Model Cell Year 100	QC-3 Model Cell Year 245	Surface Water Standard for the Most Restrictive Use	Baseline Surface Water Quality (Whitlow Ranch Dam*)	Queen Creek at Whitlow Ranch Dam Modeled Surface Water Year 41	Queen Creek at Whitlow Ranch Dam Modeled Surface Water Year 100	Queen Creek at Whitlow Ranch Dam Modeled Surface Water Year 245
Constituents with Numeric Standards										
Antimony	0.006	0.00021	0.00026	0.00034	0.00036	0.030	0.00052	0.00054	0.00059	0.00065
Arsenic	0.05	0.0013	0.0013	0.0013	0.0014	0.030	0.00235	0.0024	0.0024	0.0024
Barium	2	0.0261	0.0263	0.0263	0.0263	98	0.0350	0.035	0.035	0.035
Beryllium	0.004	0.00100	0.00100	0.00101	0.00101	0.0053	0.0010	0.0010	0.0010	0.0010
Boron	–	0.069	0.073	0.078	0.078	1	0.057	0.059	0.062	0.066
Cadmium	0.005	0.00004	0.0001	0.0002	0.0002	0.0051	0.00005[‡]	0.00007[‡]	0.00015‡	0.00020‡
Chromium, Total	0.1	0.0019	0.0022	0.0029	0.0027	1	0.0015	0.0016	0.0020	0.0023
Copper	–	0.00076	0.004	0.004	0.003	0.0234	0.00230[‡]	0.0041[‡]	0.0039‡	0.0045[‡]
Fluoride	4	0.529	0.56	0.57	0.56	140	0.4	0.42	0.43	0.43
Iron	–	0.045	0.0450	0.0450	0.0450	1	0.048	0.048	0.048	0.048
Lead	0.05	0.000065	0.00008	0.00009	0.00009	0.0083	0.00008[‡]	0.00008[‡]	0.0000[9‡]	0.00010[‡]
Manganese	–	0.0049	0.011	0.028	0.025	10	0.150	0.153	0.162	0.169
Mercury	0.002	N/A	N/A	N/A	N/A	0.00001	N/A	N/A	N/A	N/A
Nickel	0.1	0.0027	0.003	0.005	0.005	0.1343	0.0027[‡]	0.0030[‡]	0.0041[‡]	0.0050[‡]
Nitrate	10	0.38[†]	0.43	0.46	0.45	3,733.333	1.900	1.93	1.94	1.97
Nitrite	1	N/A	N/A	N/A	N/A	233.333	N/A	N/A	N/A	N/A
Selenium	0.05	0.0009	0.002	0.005	0.004	0.002	0.0007	0.0012	**0.0027**	**0.0038**
Silver	–	0.000036	0.0003	0.0009	0.0007	0.0221	0.000036	0.00016	0.00049	0.00071
Thallium	0.002	0.00003	0.00006	0.00009	0.00008	0.0072	0.000030	0.00004	0.00006	0.00008
Uranium	–	N/A	N/A	N/A	N/A	2.8	N/A	N/A	N/A	N/A
Zinc	–	0.005	0.018	0.045	0.039	0.3031	0.0030[‡]	0.0088[‡]	0.0238[‡]	0.0353[‡]
pH	–	N/A	N/A	N/A	N/A	6.5–9.0	N/A	N/A	N/A	N/A

continued

Table 3.7.2-11. Seepage water quality modeling results for Alternative 2 (mg/L) *(cont'd)*

	Aquifer Water Quality Standard	Baseline Groundwater Quality (Well DS17-17*)	QC-3 Model Cell Year 41	QC-3 Model Cell Year 100	QC-3 Model Cell Year 245	Surface Water Standard for the Most Restrictive Use	Baseline Surface Water Quality (Whitlow Ranch Dam*)	Queen Creek at Whitlow Ranch Dam Modeled Surface Water Year 41	Queen Creek at Whitlow Ranch Dam Modeled Surface Water Year 100	Queen Creek at Whitlow Ranch Dam Modeled Surface Water Year 245
Constituents without Numeric Standards										
Sulfate	–	173	186	208	209	–	136	144	154	168
Total Dissolved Solids	–	589	614	652	652	–	546	561	579	603

Notes: N/A = not analyzed in seepage modeling

Shaded cell and bolded text indicate concentrations above water quality standard.

Model data are not specific to total or dissolved fractions; for the purposes of comparison to surface water standards it can be assumed to apply to both.

* Results shown represent median values from water quality measurements

† No available data for well DS17-17. NO_3-N value calculated as median of three samples collected from Bear Tank and Benson Springs between November 2014 and March 2015

‡ Standards are hardness dependent and were calculated using lowest (most stringent) hardness value recorded for Whitlow Ranch Dam (307 mg/L $CaCO_3$ on 8/25/2017); see appendix N, table N-5, for details on how these standards were selected

total dissolved solids, sulfate). These figures depict the model results for all groundwater and surface water cells.

Modeling results for Alternative 2 indicate the following:

- Modeling estimates that engineered seepage controls can recover 99 percent of total seepage. All levels of control (Levels 0 through 4) have been applied to Alternative 2 for the purposes of estimating the effects of tailings seepage on water quality.
- For all constituents, concentrations decrease with distance from the tailings storage facility, but increase over time.
- There are no concentrations above aquifer water quality standards for the first model cell corresponding to groundwater (cell QC-3) or subsequent downgradient cells.
- Concentrations of selenium are above the surface water regulatory standard for the most restrictive use in model year 64 and onward for Queen Creek at Whitlow Ranch Dam (see appendix M, figure M-3), despite incorporation of engineered seepage controls estimated to capture 99 percent of total seepage. No other constituents are modeled to have concentrations above surface water regulatory standards. The model result is above the standard by a very small amount, and the uncertainty in the model does not allow a strict comparison. It can only be concluded that concentrations are expected to be near the standard.
- Sulfate and total dissolved solids are significant constituents in tailings seepage and can alter the potential use of downstream water resources, but do not have numeric standards. Over time, sulfate concentrations in groundwater closest to the tailings storage facility are expected to rise slightly above the 250 mg/L secondary standard, to 340 mg/L (see appendix M, figure M-1).
- Most constituents increase in concentration in groundwater and surface water above existing baseline conditions.
- The risk of not being able to meet desired seepage capture efficiencies is high. While the determination of whether water quality standards would be met is under the jurisdiction of ADEQ, the disclosure undertaken by the Forest Service suggests that the high capture efficiency required of the engineered seepage controls could make meeting water quality standards under this alternative challenging. The number and types of engineered seepage controls represent significant economic and engineering challenges.

Practicability for Additional Seepage Controls

The site-specific suite of engineered seepage controls designed for Alternative 2 is substantially more effective at controlling seepage than a fully lined facility with no other controls. The estimated loss through a full liner due to defects is 792 acre-feet per year (see Rowe (2012) and Newell and Garrett (2018d) for details of this estimate). This estimate is specifically for geomembrane as specified under Arizona BADCT; composite liners are able to reach better performance, but there are substantial logistical concerns about the ability to successfully install a full liner of any kind (see Newell and Garrett (2018d) for a summary of concerns).

Under the suite of engineered seepage controls considered (Levels 0 through 4), all parts of the foundation except those on Gila Conglomerate would already use low-permeability layers which have similar permeabilities to the Arizona BADCT specifications. The comparison to a full liner illustrates the need for layered seepage controls, particularly downstream seepage collection dams and pumpback wells, to control seepage that would be generated from within the facility, regardless of the foundation treatment.

Alternative 2 has limited ability to add further layers of seepage controls during operations. The envisioned seepage controls (Levels 0 through 4) already would extend downstream to the edge of Queen Creek. Logistically, there is little physical room to add additional controls.

RAMIFICATIONS FOR LONG-TERM CLOSURE

Post-closure Water Quality, Seepage Rates, and Closure Timing

Modeling indicates that the concentrations of constituents of concern continue to increase over time, post-closure. In addition, the estimated long-term post-closure seepage rate of 17 acre-feet per year (Gregory and Bayley 2018a) is close to the seepage rate only achieved with all Level 4 engineered seepage controls in place (20.7 acre-feet per year), including the active pumpback wells. This suggests that passive closure of the tailings storage facility may be difficult, and active management may be required.

In the alternative design, Klohn Crippen Berger Ltd. (2018a) estimated that active closure would be required up to 100 years after the end of operations. Up to 25 years after closure, the recycled water pond still is present and therefore all engineered seepage controls could remain operational, with seepage pumped back to the tailings storage facility. After 25 years, the recycled water pond is no longer present. At this time the seepage collection ponds would be expanded to maximize evaporation, and then active water management (either enhanced evaporation or treatment prior to release) would take place until the ponds could passively evaporate all incoming seepage. The sludge containing concentrated metals and salts from evaporation would eventually require cleanup and handling as solid or hazardous waste.

Financial Assurance for Closure and Post-closure Activities

Alternative 2 potentially involves long time periods of post-closure monitoring and mitigation related to stormwater or seepage water quality. This raises concern regarding the possibility of Resolution Copper going bankrupt or otherwise abandoning the property after operations have ceased. If this were to happen, the responsibility for these long-term activities would fall to the Forest Service. The Forest Service would need to have financial assurance in place to ensure adequate funds to undertake these activities for long periods of time—for decades or even longer.

The authority and mechanisms for ensuring long-term funding is discussed in section 1.5.5. The types of activities that would likely need to be funded could include the following:

- Active (such as water treatment plant) or passive (such as wetlands) water treatment systems, including design, operational maintenance, and replacement costs
- Treatment and disposal of any sludge generated by water treatment plants, or through passive evaporation
- Monitoring of water quality of seepage and downstream waters
- Maintenance and monitoring of post-closure stormwater control features
- Monitoring the water quality of stormwater runoff associated with the closure cover, to determine ability to release stormwater back to the downstream watershed

Additional financial assurance requirements for long-term maintenance and monitoring are part of the Arizona APP program:

> [T]he applicant or permittee shall demonstrate financial responsibility to cover the estimated costs to close the facility and, if necessary, to conduct postclosure monitoring and maintenance by providing to the director for approval a financial assurance mechanism or combination of mechanisms as prescribed in rules adopted by the director or in 40 Code of Federal Regulations section 264.143 (f)(1) and (10) as of January 1, 2014. (Arizona Revised Statutes 49-243; also see Arizona Administrative Code R18-9-A203 for specific regulations and methods allowed for financial assurance)

The Arizona State Mine Inspector also has authority to require a mine reclamation plan and financial assurance for mine closure (Arizona Administrative Code Title 11, Chapter 2). The regulations for these focus primarily on surface disturbance and revegetation, rather than water quality.

POTENTIAL IMPACTS ON IMPAIRED WATERS

As noted, in the project area Queen Creek is currently considered impaired for copper. The overall estimated current copper loading on this reach of Queen Creek is 0.101 kg/day. The draft TMDL for dissolved copper estimated for this reach of Queen Creek is 0.080 kg/day; this represents the total allowable amount of dissolved copper that would not result in surface water quality standards being exceeded. Note that these calculations include Resolution Copper's current permits for the West Plant Site and East Plant Site, but no discharges from a future tailings facility. ADEQ has identified the need for more than a 20 percent reduction in dissolved copper loading in order for this reach of Queen Creek to not be impaired (Arizona Department of Environmental Quality 2017).

Seepage from Alternative 2 would represent an additional dissolved copper load to Queen Creek of 0.0227 kg/day during operations and 0.0072 kg/day post-closure (see Newell and Garrett (2018d) for calculations of pollutant loading from each alternative). Alternative 2 would increase the dissolved copper load in Queen Creek by 7 to 22 percent and would interfere with efforts to reduce dissolved copper loads to Queen Creek.

PREDICTED REDUCTIONS IN ASSIMILATIVE CAPACITY

The calculated reductions in assimilative capacity are shown in table 3.7.2-12. For Alternative 2, since concentrations for selenium were already predicted to be above the surface water quality standards, by definition no assimilative capacity remains for this pollutant (table 3.7.2-12).

Table 3.7.2-12. Predicted changes in assimilative capacity due to seepage entering surface waters

Alternative	Receiving Water	Remaining Assimilative Capacity After Seepage Enters Surface Water
Alternative 2	Queen Creek at Whitlow Ranch Dam	Selenium (0%); the selenium concentration is above the numeric surface water quality standard
Alternative 3	Queen Creek at Whitlow Ranch Dam	No changes in assimilative capacity greater than 20 percent are anticipated
Alternative 4	Queen Creek at Whitlow Ranch Dam	Selenium (0%); the selenium concentration is above the numeric surface water quality standard
Alternative 5	Gila River below Donnelly Wash	Copper (77%); Selenium (63%)
Alternative 6	Gila River below Dripping Spring Wash	Selenium (67%)

Note: For full calculations, see Newell and Garrett (2018d); this document also contains an assessment of potential changes in assimilative capacity due to reductions in stormwater runoff discussed in section 3.7.3.

Alternative 3 – Near West – Ultrathickened

POTENTIAL WATER QUALITY IMPACTS FROM TAILINGS STORAGE FACILITY

Seepage Controls Incorporated into Design

The various engineered seepage controls assessed in the Alternative 3 design and how they are expected to be applied are shown in table 3.7.2-13. A conceptual diagram of the seepage controls is shown in figure 3.7.2-6. These are almost entirely identical to Alternative 2, except in Alternative 3 a low-permeability layer is used for the entire PAG cell starting with Level 1 controls.

Anticipated Effectiveness of Seepage Controls

As with Alternative 2, total seepage was estimated during the initial design phase using a one-dimensional, unsaturated flow model (Klohn

Table 3.7.2-13. Effectiveness of Alternative 3 engineered seepage controls

Seepage Control Levels and Components	Uncaptured Seepage from Facility	Source
Uncontrolled seepage from tailings facility	728 acre-feet/year	Groenendyk and Bayley (2018b) and Klohn Crippen Berger Ltd. (2018b)
Level 0 (seepage controls for geotechnical stability)		
- Modified centerline cyclone sand embankment - Blanket drain under embankment; finger drains	Not explicitly modeled; incorporated into Level 1 modeling	
Level 0-1		
- Blanket drain extends into facility under NPAG beach; finger drains (blanket/finger drains account for roughly 88% of seepage collected) - Seepage collection ponds with pumpback wells and cut-off walls	116 acre-feet/year	Groenendyk and Bayley (2018a)
Level 1		
- Foundation treatment and selected areas of engineered low-permeability layers, for all areas not Gila Conglomerate - Engineered low-permeability layer for entire PAG facility - Seepage collection ponds with pumpback wells, cut-off walls, and grout curtain to 100-foot depth	Not explicitly modeled; incorporated into Level 4 modeling	N/A
Level 2		
- Grout curtain extended to target high-permeability zones and seepage pathways	Not explicitly modeled; incorporated into Level 4 modeling	N/A
Level 3		
- Add second perimeter of seepage collection ponds downstream	Not explicitly modeled; incorporated into Level 4 modeling	N/A
Level 4 (includes Levels 0 through 4)		
- Add pumpback wells, cut-off walls, and grout curtains to second perimeter of seepage collection ponds - Downgradient grout curtain extending to 100-foot depth - Additional pumpback wells in targeted areas to maximize capture	2.7 acre-feet/year	Groenendyk and Bayley (2019)

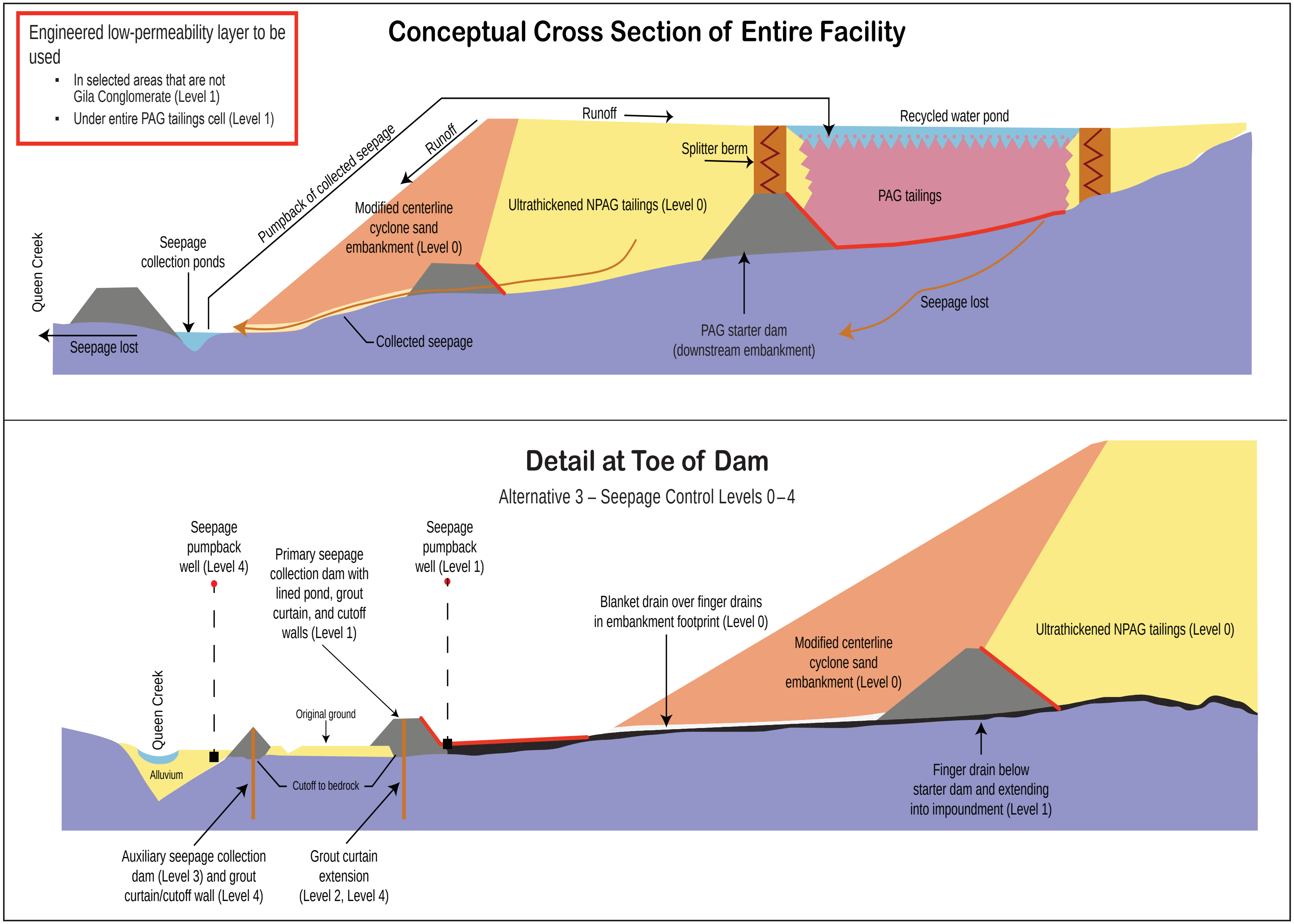


Figure 3.7.2-6. Alternative 3 seepage controls

Crippen Berger Ltd. 2018b), and a three-dimensional groundwater flow model was used to model the amount of total seepage that would be captured by various engineered seepage controls, leaving some amount of lost seepage to enter the environment downgradient (Groenendyk and Bayley 2018b, 2019).

During operations, total seepage created by the tailings was estimated at 728 acre-feet per year (508 and 220 acre-feet per year of NPAG and PAG seepage, respectively) and lost seepage was modeled to be 116 acre-feet per year with Level 1 seepage controls, and 2.7 acre-feet per year with all enhanced engineered seepage controls (Level 4).

Modeling indicates the Level 4 seepage controls would reach a seepage capture efficiency of 99.5 percent. Most of this is captured by blanket and finger drains (88 percent).

Risk of Seepage Impacting Groundwater or Surface Water Quality

Modeled results for groundwater and surface water impacts are reported by Gregory and Bayley (2019). The detailed results of the bypass seepage mixing/loading model were supplied as an Excel spreadsheet, and can be found in Garrett (2019c). Table 3.7.2-14 presents model results for all modeled chemical constituents in the first groundwater cell along Queen Creek (cell QC-3)[53] and the ultimate, final surface water cell (Queen Creek at Whitlow Ranch Dam), for model years 41, 100, and 245. This provides perspective on trends and expected conditions at the end of mining and in the long term. Table 3.7.2-14 also presents Arizona water quality standards and baseline chemistry for added perspective.

Figures M-8 through M-14 in appendix M illustrate model results for the seven constituents of concern.

Modeling results for Alternative 3 indicate the following:

- Modeling estimates that engineered seepage controls can recover 99.5 percent of total seepage. All levels of control (Levels 0 through 4) have been applied to Alternative 3 for the purposes of estimating the effects of tailings seepage on water quality.
- For all constituents, concentrations decrease with distance from the tailings storage facility, but increase over time.
- No chemical constituent are anticipated in concentrations above groundwater or surface water standards.
- Selenium and cadmium are increased slightly above baseline conditions in groundwater and surface water (see appendix M, figures M-10 and M-11).
- The risk of not being able to meet desired seepage capture efficiencies is high. While the determination of whether water quality standards would be met is under the jurisdiction of ADEQ, the disclosure undertaken by the Forest Service suggests that the high capture efficiency required of the engineered seepage controls could make meeting water quality standards under this alternative challenging. The number and types of engineered seepage controls represent significant economic and engineering challenges.

Practicability for Additional Seepage Controls

The assessment of practicability of using a full liner, or adding extra layers of seepage controls during operations, is the same as for Alternative 2.

53. Similar to Alternative 2, results are included in the modeling for several washes that would receive lost seepage (Potts and Roblas Canyons), which are upgradient from cell QC-3. It is not likely that substantial groundwater exists in these alluvial channels; these modeled results are indicative of seepage itself, rather than groundwater concentrations expected in the aquifer.

Table 3.7.2-14. Seepage water quality modeling results for Alternative 3 (mg/L)

	Aquifer Water Quality Standard	Baseline Groundwater Quality (Well DS17-17*)	QC-3 Model Cell Year 41	QC-3 Model Cell Year 100	QC-3 Model Cell Year 245	Surface Water Standard for Most Restrictive Use	Baseline Surface Water Quality (Whitlow Ranch Dam*)	Queen Creek at Whitlow Ranch Dam Modeled Surface Water Year 41	Queen Creek at Whitlow Ranch Dam Modeled Surface Water Year 100	Queen Creek at Whitlow Ranch Dam Modeled Surface Water Year 245
Constituents with Numeric Standards										
Antimony	0.006	0.00021	0.00021	0.00021	0.00022	0.030	0.00052	0.00052	0.00052	0.00053
Arsenic	0.05	0.0013	0.0013	0.0013	0.0013	0.030	0.00235	0.0024	0.0024	0.0024
Barium	2	0.0261	0.0261	0.0261	0.0261	98	0.035	0.035	0.035	0.035
Beryllium	0.004	0.00100	0.00100	0.00100	0.00100	0.0053	0.0010	0.0010	0.0010	0.0010
Boron	–	0.069	0.069	0.069	0.069	1	0.057	0.057	0.057	0.057
Cadmium	0.005	0.00004	0.0000	0.0000	0.0001	0.0051	0.00005‡	0.00005‡	0.00005‡	0.00006‡
Chromium, Total	0.1	0.0019	0.0019	0.0019	0.0020	1	0.0015	0.0015	0.0015	0.0015
Copper	–	0.00076	0.001	0.001	0.001	0.0234	0.00230‡	0.0023‡	0.0024‡	0.0024‡
Fluoride	4	0.529	0.53	0.53	0.53	140	0.4	0.41	0.41	0.41
Iron	–	0.045	0.0450	0.0450	0.0450	1	0.048	0.048	0.048	0.048
Lead	0.05	0.000065	0.00007	0.00007	0.00007	0.0083	0.00008‡	0.00008‡	0.00008‡	0.00008‡
Manganese	–	0.0049	0.005	0.005	0.007	10	0.150	0.150	0.150	0.151
Mercury	0.002	N/A	N/A	N/A	N/A	0.00001	N/A	N/A	N/A	N/A
Nickel	0.1	0.0027	0.003	0.003	0.003	0.1343	0.0027‡	0.0027‡	0.0027‡	0.0028‡
Nitrate	10	0.38†	0.38	0.38	0.39	3,733.333	1.90	1.90	1.90	1.90
Nitrite	1	N/A	N/A	N/A	N/A	233.333	N/A	N/A	N/A	N/A
Selenium	0.05	0.0009	0.001	0.001	0.001	0.002	0.0007	0.0007	0.0007	0.0009
Silver	–	0.000036	0.0000	0.0001	0.0001	0.0221	0.000036	0.00004	0.00005	0.00007
Thallium	0.002	0.00003	0.00003	0.00003	0.00004	0.0072	0.000030	0.00003	0.00003	0.00003
Uranium	–	N/A	N/A	N/A	N/A	2.8	N/A	N/A	N/A	N/A
Zinc	–	0.005	0.005	0.006	0.008	0.3031	0.0030‡	0.0030‡	0.0034‡	0.0045‡
pH	–	N/A	N/A	N/A	N/A	6.5–9.0	N/A	N/A	N/A	N/A

continued

Table 3.7.2-14. Seepage water quality modeling results for Alternative 3 (mg/L) *(cont'd)*

	Aquifer Water Quality Standard	Baseline Groundwater Quality (Well DS17-17*)	QC-3 Model Cell Year 41	QC-3 Model Cell Year 100	QC-3 Model Cell Year 245	Surface Water Standard for Most Restrictive Use	Baseline Surface Water Quality (Whitlow Ranch Dam*)	Queen Creek at Whitlow Ranch Dam Modeled Surface Water Year 41	Queen Creek at Whitlow Ranch Dam Modeled Surface Water Year 100	Queen Creek at Whitlow Ranch Dam Modeled Surface Water Year 245
Constituents without Numeric Standards										
Sulfate	–	173	173	174	176	–	136	136	136	138
Total Dissolved Solids	–	589	589	590	594	–	546	546	546	549

Notes: N/A= not analyzed in seepage modeling

Model data are not specific to total or dissolved fractions; for the purposes of comparison to surface water standards it can be assumed to apply to both.

* Results shown represent median values from water quality measurements.

† No available data for well DS17-17. NO_3-N value calculated as median of three samples collected from Bear Tank and Benson Springs between November 2014 and March 2015.

‡ Standards are hardness dependent and were calculated using lowest (most stringent) hardness value recorded for Whitlow Ranch Dam (307 mg/L $CaCO_3$ on 8/25/2017); see appendix N, table N-5, for details on how these standards were selected

RAMIFICATIONS FOR LONG-TERM CLOSURE

Post-closure Water Quality, Seepage Rates, and Closure Timing

Modeling indicates that the concentrations of constituents of concern continue to increase over time, post-closure. In the alternative design, KCB (2018b) estimated that active closure would only be required up to 9 years after the end of operations. At that time, the seepage collection ponds would be expanded to maximize evaporation; passive evaporation of all incoming seepage was anticipated. The sludge of concentrated metals and salts from evaporation would likely eventually require cleanup and handling as solid or hazardous waste.

The final seepage modeling assumes that long-term lost seepage rates would match those during operations (2.7 acre-feet per year), which is much lower than original estimates of long-term recharge through the tailings storage facility caused by infiltration of precipitation (25 acre-feet per year (Gregory and Bayley 2018a)). This suggests that active management may be needed indefinitely post-closure.

Financial Assurance for Closure and Post-closure Activities

The regulatory framework to require financial assurance to ensure closure and post-closure activities are conducted is the same as for Alternative 2.

POTENTIAL IMPACTS ON IMPAIRED WATERS

As noted, in the project area Queen Creek is currently considered impaired for copper. The overall estimated current loading on this reach of Queen Creek is 0.101 kg/day. The draft TMDL for dissolved copper estimated for this reach of Queen Creek is 0.080 kg/day; this represents the total allowable amount of dissolved copper that would not result in surface water quality standards being exceeded. Note that these calculations include Resolution Copper's current permits for the West Plant Site and East Plant Site, but no discharges from a tailings facility. ADEQ has identified the need for more than a 20 percent reduction in dissolved copper loading in order for this reach of Queen Creek to not be impaired (Arizona Department of Environmental Quality 2017).

Seepage from Alternative 3 would represent an additional dissolved copper load to Queen Creek of 0.0018 kg/day during operations and 0.0010 kg/day post-closure (see Newell and Garrett (2018d) for calculations of pollutant loading from each alternative). Alternative 3 would increase the dissolved copper load in Queen Creek by 1 to 2 percent and would minimally interfere with efforts to reduce dissolved copper loads to Queen Creek.

PREDICTED REDUCTIONS IN ASSIMILATIVE CAPACITY

The calculated reductions in assimilative capacity are shown in table 3.7.2-12. For Alternative 3, seepage is not anticipated to use up more than 20 percent of the assimilative capacity in Queen Creek.

Alternative 4 – Silver King

POTENTIAL WATER QUALITY IMPACTS FROM TAILINGS STORAGE FACILITY

Seepage Controls Incorporated into Design

Alternative 4 includes the following seepage controls, similar in nature to those described for Alternative 2. A conceptual diagram of the seepage controls is shown in figure 3.7.2-7. Table 3.7.2-15 summarizes how these are expected to be applied:

- Blanket drains and/or finger drains beneath the embankment and the tailings facility (Level 0).
- Lined collection ditches and five seepage collection ponds downstream of PAG and NPAG facilities designed to cut off the alluvium (Level 1).
- Grouting of fractures in the bedrock foundation, and pumpback wells (Level 2).

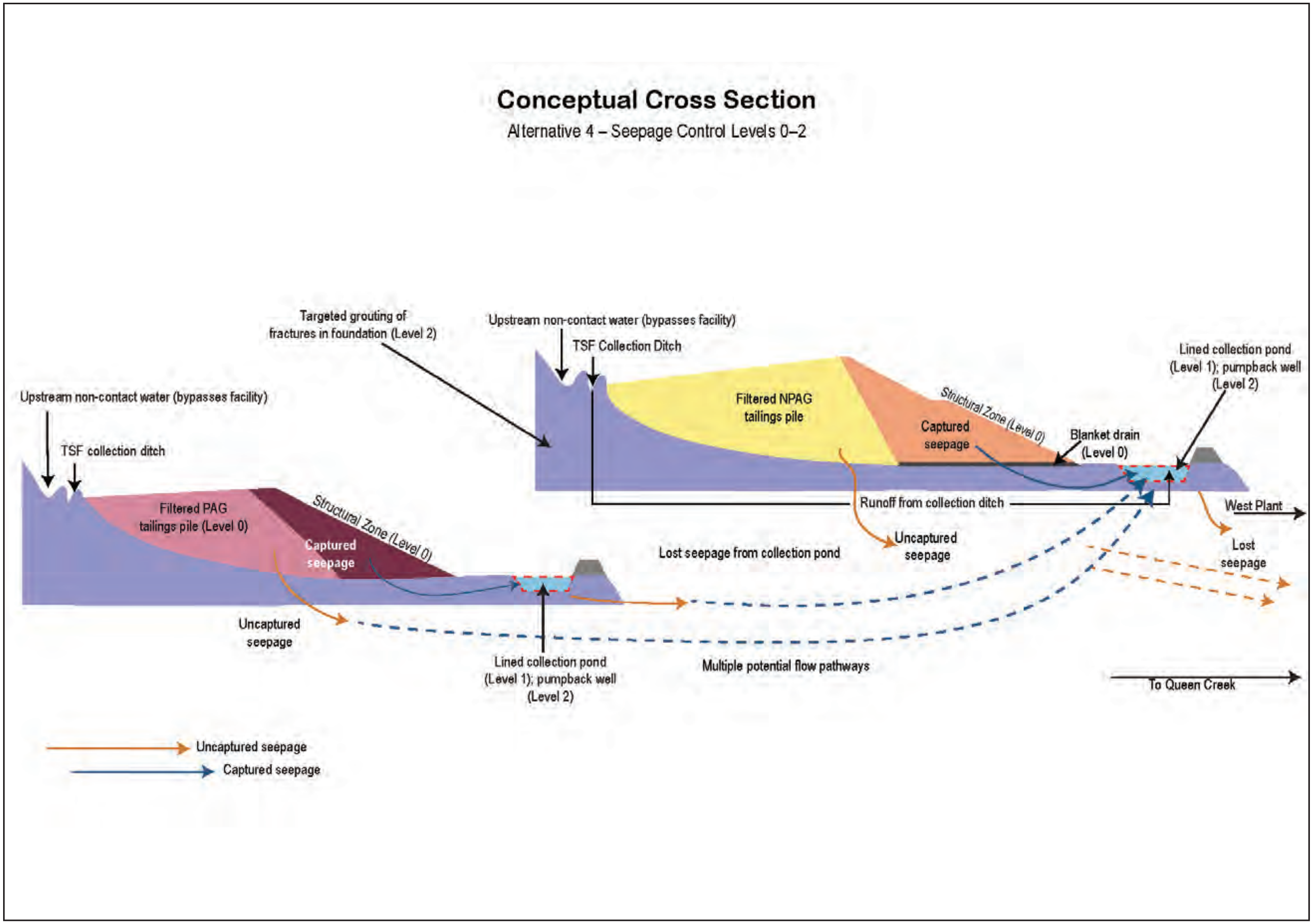


Figure 3.7.2-7. Alternative 4 seepage controls

Table 3.7.2-15. Effectiveness of Alternative 4 engineered seepage controls

Seepage Control Levels and Components	Uncaptured Seepage from Facility	Source
Uncontrolled seepage from tailings facility	79 acre-feet/year	Klohn Crippen Berger Ltd. (2019b)
Level 0 (seepage controls for geotechnical stability)		
- Dewatered (filtered) tailings - Compacted structural zone - Blanket drain under structural zone; finger drains	Not explicitly modeled; incorporated into Level 1 modeling	N/A
Level 1		
- Lined collection ditches and ponds in alluvial channels - Based on professional judgement, estimated to have no greater than 80% efficiency at seepage control	17 acre-feet per year or more	Klohn Crippen Berger Ltd. (2019b)
Level 2		
- Targeted grouting of fractures in foundation - Pumpback wells for seepage return - Based on professional judgment, estimated to have no greater than 90% efficiency at seepage control	9 acre-feet per year or more	Klohn Crippen Berger Ltd. (2019b)

Anticipated Effectiveness of Seepage Controls

For Alternative 4 – Silver King, total seepage was estimated during the initial design phase using a one-dimensional, unsaturated flow model (Klohn Crippen Berger Ltd. 2018c). Unlike Alternatives 2 and 3, there is limited information on the hydrology and geology of the proposed Silver King tailings location and constructing a similar three-dimensional steady-state flow model is not feasible. The efficiency of seepage capture was estimated instead, based on professional judgment of the design engineers and an understanding of the potential flow pathways for seepage. Based on the professional judgement of the design engineers, it is estimated that these seepage controls would capture no more than 80 percent of seepage using Level 1 controls and no more than 90 percent of seepage using Level 2 controls (Klohn Crippen Berger Ltd. 2019b).

During operations, total seepage created by the tailings was estimated at 79 acre-feet per year (77.5 and 1.9 acre-feet per year of NPAG and PAG seepage, respectively) and lost seepage was modeled to be 17 or more acre-feet per year with Level 1 seepage controls, and 9 or more acre-feet per year with all enhanced engineered seepage controls (Level 2).

Risk of Seepage Impacting Groundwater or Surface Water Quality

Modeled results for groundwater and surface water impacts are reported by Gregory and Bayley (2019). The detailed results of the bypass seepage mixing/loading model were supplied as an Excel spreadsheet, and can be found in Garrett (2019c). Table 3.7.2-16 presents model results for all modeled chemical constituents in the first groundwater cell along Queen Creek (cell QC-1)[54] and the ultimate surface water cell (Queen Creek at Whitlow Ranch Dam), for model years 41, 100, and 245. This provides perspective on trends and expected conditions at the end of mining and in the long term. Table 3.7.2-16 also presents Arizona water quality standards and baseline chemistry for added perspective.

Figures M-15 through M-21 in appendix M illustrate model results for the seven constituents of concern.

Modeling results for Alternative 4 indicate the following:

- The model results rely on the 90 percent estimated efficiency of engineered seepage controls, which is not based on technical analysis (unlike Alternatives 2, 3, 5, and 6) but on professional judgment.
- For all constituents, concentrations decrease with distance from the tailings storage facility, but increase over time.
- There are no concentrations above aquifer water quality standards for the first model cell corresponding to groundwater (cell QC-1) or subsequent downgradient cells. Note that although Gregory and Bayley (2019) report that concentrations are above groundwater standards for Alternative 4, their conclusion is based upon the interpretation of first groundwater occurring in the alluvial channels very close to the tailings storage facility. As noted above, it is not likely that groundwater actually occurs until further downgradient, near Queen Creek.
- Concentrations of selenium are above the surface water regulatory standard for the most restrictive use in model years 59 and onward for Queen Creek at Whitlow Ranch Dam (see appendix M, figure M-17), despite incorporation of engineered seepage controls estimated to capture 90 percent of total seepage. No other constituents are modeled to have concentrations above surface water regulatory standards. The model result is above the standard by a very small amount, and the uncertainty in the model does not allow a strict comparison. It can only be concluded that concentrations are expected to be near the standard.

54. Results are included in the modeling for several washes that would receive lost seepage (Happy Camp Wash East and West, Silver King Wash, Potts Canyon), which are upgradient from cell QC-1. It is not likely that substantial groundwater exists in these alluvial channels; these modeled results are indicative of seepage itself, rather than groundwater concentrations expected in the aquifer.

Table 3.7.2-16. Seepage water quality modeling results for Alternative 4 (mg/L)

	Aquifer Water Quality Standard	Baseline Groundwater Quality (Well DS17-17*)	QC-3 Model Cell Year 41	QC-3 Model Cell Year 100	QC-3 Model Cell Year 245	Surface Water Standard for Most Restrictive Use	Baseline Surface Water Quality (Whitlow Ranch Dam*)	Queen Creek at Whitlow Ranch Dam Modeled Surface Water Year 41	Queen Creek at Whitlow Ranch Dam Modeled Surface Water Year 100	Queen Creek at Whitlow Ranch Dam Modeled Surface Water Year 245
Constituents with Numeric Standards										
Antimony	0.006	0.00021	0.00022	0.00052	0.00074	0.030	0.00052	0.00052	0.00068	0.00080
Arsenic	0.05	0.0013	0.0013	0.0016	0.0018	0.030	0.00235	0.0024	0.0025	0.0026
Barium	2	0.0261	0.0263	0.0263	0.0264	98	0.0350	0.035	0.035	0.035
Beryllium	0.004	0.00100	0.00102	0.00102	0.00104	0.0053	0.0010	0.0010	0.0010	0.0010
Boron	–	0.069	0.069	0.082	0.091	1	0.057	0.057	0.064	0.069
Cadmium	0.005	0.00004	0.0000	0.0003	0.0004	0.0051	0.00005‡	0.00005‡	0.00016‡	0.00023‡
Chromium, Total	0.1	0.0019	0.0019	0.0026	0.0030	1	0.0015	0.0015	0.0019	0.0021
Copper	–	0.00076	0.003	0.004	0.006	0.0234	0.00230‡	0.0035‡	0.0038‡	0.0049‡
Fluoride	4	0.529	0.53	0.56	0.58	140	0.4	0.41	0.42	0.43
Iron	–	0.045	0.0450	0.0450	0.0450	1	0.048	0.048	0.048	0.048
Lead	0.05	0.000065	0.00007	0.00012	0.00015	0.0083	0.00008‡	0.00008‡	0.00010‡	0.00012‡
Manganese	–	0.0049	0.010	0.060	0.088	10	0.150	0.153	0.178	0.194
Mercury	0.002	N/A	N/A	N/A	N/A	0.00001	N/A	N/A	N/A	N/A
Nickel	0.1	0.0027	0.004	0.007	0.009	0.1343	0.0027‡	0.0031‡	0.0047‡	0.0060‡
Nitrate	10	0.38†	0.40	0.40	0.42	3,733.333	1.90	1.91	1.91	1.92
Nitrite	1	N/A	N/A	N/A	N/A	233.333	N/A	N/A	N/A	N/A
Selenium	0.05	0.0009	0.001	0.006	0.008	0.002	0.0007	0.0007	**0.0031**	**0.0046**
Silver	–	0.000036	0.0000	0.0009	0.0014	0.0221	0.000036	0.00004	0.0005	0.00074
Thallium	0.002	0.00003	0.00003	0.00009	0.00012	0.0072	0.000030	0.00003	0.00006	0.00008
Uranium	–	N/A	N/A	N/A	N/A	2.8	N/A	N/A	N/A	N/A
Zinc	–	0.005	0.006	0.053	0.081	0.3031	0.0030‡	0.0036‡	0.0281‡	0.0428‡
pH	–	N/A	N/A	N/A	N/A	6.5–9.0	N/A	N/A	N/A	N/A

continued

Table 3.7.2-16. Seepage water quality modeling results for Alternative 4 (mg/L) *(cont'd)*

	Aquifer Water Quality Standard	Baseline Groundwater Quality (Well DS17-17*)	QC-3 Model Cell Year 41	QC-3 Model Cell Year 100	QC-3 Model Cell Year 245	Surface Water Standard for Most Restrictive Use	Baseline Surface Water Quality (Whitlow Ranch Dam*)	Queen Creek at Whitlow Ranch Dam Modeled Surface Water Year 41	Queen Creek at Whitlow Ranch Dam Modeled Surface Water Year 100	Queen Creek at Whitlow Ranch Dam Modeled Surface Water Year 245
Constituents without Numeric Standards										
Sulfate	–	173	175	212	241	–	136	137	156	172
Total Dissolved Solids	–	589	592	647	688	–	546	547	576	598

Notes: N/A= not analyzed in seepage modeling

Shaded cell and bolded text indicate concentrations above water quality standard.

Model data are not specific to total or dissolved fractions; for the purposes of comparison to surface water standards it can be assumed to apply to both.

* Results shown represent median values from water quality measurements.

† No available data for well DS17-17. NO_3-N value calculated as median of three samples collected from Bear Tank and Benson Springs between November 2014 and March 2015.

‡ Standards are hardness dependent and were calculated using lowest (most stringent) hardness value recorded for Whitlow Ranch Dam (307 mg/L $CaCO_3$ on 8/25/2017); see appendix N, table N-5, for details on how these standards were selected.

- Sulfate and total dissolved solids are significant constituents in tailings seepage and can alter the potential use of downstream water resources, but do not have numeric standards. Over time, sulfate concentrations in groundwater closest to the tailings storage facility are expected to rise slightly above the 250 mg/L secondary standard, to 284 mg/L (see appendix M, figure M-15).
- Most constituents increase in concentration in groundwater and surface water above existing baseline conditions.
- Of all the alternatives, Alternative 4 is the only one where seepage control effectiveness was not able to be modeled; instead this alternative relies on professional engineering judgment for the effectiveness of the seepage controls. Additional controls could be needed; the practicability of this is described in the following section.

Practicability for Additional Seepage Controls

The amount of seepage without engineered controls is considerably less for Alternative 4, compared with the other alternatives, with only 79 acre-feet per year. The estimated loss through a full liner is about 550 acre-feet per year for a 2,300-acre facility. This estimate is specifically for a geomembrane as specified under Arizona BADCT; composite liners are able to reach better performance, but there are substantial logistical concerns about the ability to successfully install a full liner of any kind, and the terrain at Alternative 4 was specifically considered for feasibility (see Newell and Garrett (2018d) for a summary of concerns).

Unlike Alternatives 2 and 3, Alternative 4 has more ability to add further layers of seepage control during operations. For instance, there is room to install additional downstream seepage collection ponds with cut-off walls and pumpback wells, in Silver King Wash and Happy Camp Wash. The greater distance downstream to Queen Creek allows more flexibility during operations for this location, compared with Alternatives 2 and 3.

RAMIFICATIONS FOR LONG-TERM CLOSURE

Post-closure Water Quality, Seepage Rates, and Closure Timing

Modeling indicates that the concentrations of constituents of concern continue to increase over time, post-closure. Post-closure seepage rates are estimated as 15.2 to 31.9 acre-feet per year (Wickham 2018).

In the alternative design, Klohn Crippen Berger Ltd. (2018c) estimated that active closure would be required for 5 years after the end of operations. During this time, reclamation of the exposed tailings would be in progress, and the need to retain stormwater in the collection ponds requires more capacity than the collection ponds can passively evaporate and may require active treatment. Once stormwater can again be released downstream, after the tailings surface has been reclaimed with a stable closure cover, the collection ponds would be able to passively evaporate collected water. The sludge of concentrated metals and salts from evaporation would likely eventually require cleanup and handling as solid or hazardous waste.

Financial Assurance for Closure and Post-closure Activities

The regulatory framework to require financial assurance to ensure closure and post-closure activities are conducted is the same as for Alternatives 2 and 3.

POTENTIAL IMPACTS ON IMPAIRED WATERS

As noted, in the project area Queen Creek is currently considered impaired for copper. The overall estimated current loading on this reach of Queen Creek is 0.101 kg/day. The draft TMDL for dissolved copper estimated for this reach of Queen Creek is 0.080 kg/day; this represents the total allowable amount of dissolved copper that would not result in surface water quality standards being exceeded. Note that these calculations include Resolution Copper's current permits for the West Plant Site and East Plant Site, but no discharges from a tailings facility.

ADEQ has identified the need for more than a 20 percent reduction in dissolved copper loading in order for this reach of Queen Creek to not be impaired (Arizona Department of Environmental Quality 2017).

Seepage from Alternative 4 would represent an additional dissolved copper load to Queen Creek of 0.0116 kg/day during operations and 0.0217 kg/day post-closure (see Newell and Garrett (2018d) for calculations of pollutant loading from each alternative). Alternative 4 would increase the dissolved copper load in Queen Creek by 11 to 21 percent and would interfere with efforts to reduce dissolved copper loads to Queen Creek.

PREDICTED REDUCTIONS IN ASSIMILATIVE CAPACITY

The calculated reductions in assimilative capacity are shown in Table 3.7.2-12. For Alternative 4, since concentrations for selenium were already predicted to be above the surface water quality standards, by definition no assimilative capacity remains for this pollutant.

Alternative 5 – Peg Leg

POTENTIAL WATER QUALITY IMPACTS FROM TAILINGS STORAGE FACILITY

Seepage Controls Incorporated into Design

Alternative 5 includes the following seepage controls, similar in nature to those described for Alternative 2. A conceptual diagram of the seepage controls is shown in figure 3.7.2-8. Table 3.7.2-17 summarizes how these are expected to be applied:

- Blanket drains beneath the embankment (Level 0)
- Lined collection ditches and six seepage collection ponds (Level 1)
- A geomembrane (HDPE) over 300 acres where the initial recycled water pond would be, in order to maintain operational control of tailings deposition (Level 1)
- An engineered low-permeability layer under the entire separate PAG cell (Level 1); under Level 2 controls this would be upgraded to a full synthetic liner and additional foundation preparation to remove material down to bedrock
- A pumpback well system (Level 1)
- Use of thin-lift deposition in Year 7 once adequate room becomes available (Level 2)

Anticipated Effectiveness of Seepage Controls

For Alternative 5, total seepage estimates are based on an “Order of Magnitude” water balance estimated using a two-dimensional finite element model (SLIDE V7.0) (Golder Associates Inc. 2018a).

The amount of lost seepage for Alternative 5 is calculated in a different manner than other alternatives. Much of the foundation consists of a deep alluvial aquifer associated with Donnelly Wash, which results in substantial seepage losses even with engineered seepage controls built into the facility. Therefore, a downstream pumpback system is a key component of the engineered seepage controls. The amount of flow the alluvial aquifer is able to handle was estimated and a downstream pumpback well system is expected to remove enough water to maintain the aquifer at equilibrium.

During operations, total seepage created by the tailings was estimated at 3,930 acre-feet per year (2,660 and 1,270 acre-feet per year of NPAG and PAG seepage, respectively) and lost seepage was modeled to be 1,317 acre-feet per year with Level 1 seepage controls, and 261 acre-feet per year with all enhanced engineered seepage controls (Level 2).

Modeling indicates the Level 2 seepage controls would reach a seepage capture efficiency of 84 percent of the seepage. It is important to note that the pumpback well system is adjusted under Level 2 and pumpage is reduced to only what is needed to control water quality; substantial additional pumping could be undertaken if needed at this location.

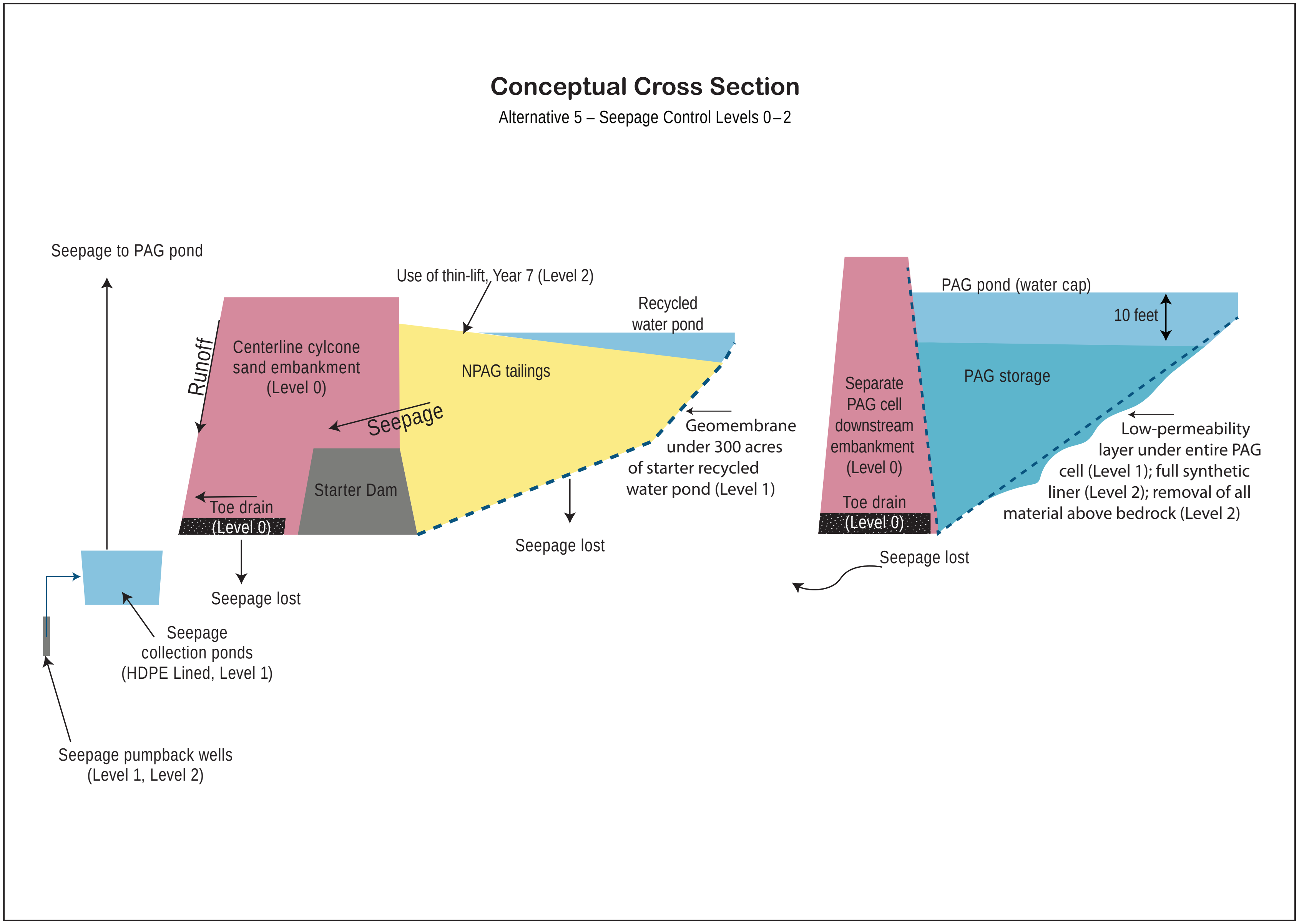


Figure 3.7.2-8. Alternative 5 seepage controls

Table 3.7.2-17. Effectiveness of Alternative 5 engineered seepage controls

Seepage Control Levels and Components	Uncaptured Seepage from Facility	Source
Uncontrolled seepage from tailings facility	3,930 acre-feet/year	Klohn Crippen Berger Ltd. (2019d)
Level 0 (seepage controls for geotechnical stability)		
- Centerline cyclone sand embankment - Blanket drain under embankment - Separate PAG and NPAG cells	Not explicitly modeled; incorporated into Level 1 modeling	N/A
Level 1		
- Lined seepage collection ditches and ponds - Finger drains under facility along natural drainages - 300 acres of geomembrane (HDPE) underneath recycled water pond - Engineered low-permeability layer under entire PAG cell - Pumpback well system to control downgradient flow	1,317 acre-feet per year	Klohn Crippen Berger Ltd. (2019d)
Level 2		
- Full synthetic liner below entire PAG cell - Removal of all material above bedrock below PAG cell - Thin-lift deposition to start in year 7 (requires sufficient room) - Adjustment to pumpback well system, reducing pumping to just amount necessary to control water quality	261 acre-feet per year	Kidner and Pilz (2019) and Klohn Crippen Berger Ltd. (2019d)

Table 3.7.2-18. Seepage water quality modeling results for Alternative 5 (mg/L)

	Aquifer Water Quality Standard	Baseline Groundwater Quality (Tea Cup Well*)	DW-2 Model Cell Year 41	DW-2 Model Cell Year 100	DW-2 Model Cell Year 245	Surface Water Standard for Most Restrictive Use	Baseline Surface Water Quality (Gila River below Donnelly Wash**)	Gila River below Donnelly Wash Modeled Surface Water Year 41	Gila River below Donnelly Wash Modeled Surface Water Year 100	Gila River below Donnelly Wash Modeled Surface Water Year 245
Constituents with Numeric Standards										
Antimony	0.006	0.00003	0.00003	0.00044	0.00214	0.030	0.00023	0.00023	0.00023	0.00025
Arsenic	0.05	0.0021	0.0021	0.0022	0.0032	0.030	0.00889	0.0089	0.0089	0.0089
Barium	2	0.0428	0.0428	0.0442	0.0483	98	0.0826	0.083	0.083	0.083
Beryllium	0.004	0.0010	0.00100	0.00104	0.00202	0.0053	0.0017	0.0017	0.0017	0.0017
Boron	–	0.082	0.082	0.112	0.205	1	0.190	0.190	0.190	0.191
Cadmium	0.005	0.00004	0.0000	0.0006	0.0026	0.0049	0.00006[‡]	0.00006[‡]	0.00006[‡]	0.00009[‡]
Chromium, Total	0.1	0.0019	0.0019	0.0050	0.0137	1	0.0020	0.0020	0.0020	0.0021
Copper	–	0.00330	0.003	0.034	1.035	0.0222	0.00408[‡]	0.0041[‡]	0.0041[‡]	0.0099[‡]
Fluoride	4	0.68	0.68	0.90	1.71	140	0.987	0.99	0.99	1.00
Iron	–	0.045	0.0450	0.0452	0.0470	1	0.056	0.056	0.056	0.056
Lead	0.05	0.002630	0.00263	0.00274	0.00321	0.0078	0.00015[‡]	0.00015[‡]	0.00015[‡]	0.00016[‡]
Manganese	–	0.0049	0.005	0.075	0.580	10	0.028	0.028	0.028	0.033
Mercury	0.002	N/A	N/A	N/A	N/A	0.00001	N/A	N/A	N/A	N/A
Nickel	0.1	0.0027	0.003	0.012	0.085	0.1280	0.0023[‡]	0.0023[‡]	0.0023[‡]	0.0030[‡]
Nitrate	10	**15.20[†]**	**15.26**	**15.53**	**16.34**	3,733.333	0.091	0.09	0.09	0.11
Nitrite	1	N/A	N/A	N/A	N/A	233.333	N/A	N/A	N/A	N/A
Selenium	0.05	0.0011	0.001	0.013	0.050	0.002	0.0004	0.0004	0.0004	0.0010
Silver	–	0.000036	0.0000	0.0026	0.0100	0.0201	0.000061	0.00006	0.00006	0.00018
Thallium	0.002	0.00003	0.00003	0.00024	0.00073	0.0072	0.000080	0.00008	0.00008	0.00009
Uranium	–	N/A	N/A	N/A	N/A	2.8	N/A	N/A	N/A	N/A
Zinc	–	0.016	0.016	0.132	0.560	0.2888	0.0050[‡]	0.0050[‡]	0.0050[‡]	0.0109[‡]
pH	–	N/A	N/A	N/A	N/A	6.5–9.0	N/A	N/A	N/A	N/A

continued

Table 3.7.2-18. Seepage water quality modeling results for Alternative 5 (mg/L) *(cont'd)*

	Aquifer Water Quality Standard	Baseline Groundwater Quality (Tea Cup Well*)	DW-2 Model Cell Year 41	DW-2 Model Cell Year 100	DW-2 Model Cell Year 245	Surface Water Standard for Most Restrictive Use	Baseline Surface Water Quality (Gila River below Donnelly Wash**)	Gila River below Donnelly Wash Modeled Surface Water Year 41	Gila River below Donnelly Wash Modeled Surface Water Year 100	Gila River below Donnelly Wash Modeled Surface Water Year 245
Constituents without Numeric Standards										
Sulfate	–	59	59	138	594	–	159	159	159	164
Total Dissolved Solids	–	523	523	648	1,338	–	776	776	776	783

Notes: N/A= not analyzed in seepage modeling

Shaded cell and bolded text indicate concentrations above water quality standard.

Model data are not specific to total or dissolved fractions; for the purposes of comparison to surface water standards it can be assumed to apply to both.

* Assumed concentrations are based on single sample collected on 27 September 2017 and are therefore approximate.

** Assumed concentrations are based on single sample collected on 13 November 2018 and are therefore approximate.

† NO_3-N concentration shown is above its standard; additional water quality monitoring is required to determine if value is representative of aquifer water quality or due to localized contamination

‡ Standards are hardness dependent and were calculated using a hardness value of 290 mg/L $CaCO_3$ (from sample collected on 13 November 2018); see appendix N, table N-5 for details on how these standards were selected

Risk of Seepage Impacting Groundwater or Surface Water Quality

Modeled results for groundwater and surface water impacts are reported by Gregory and Bayley (2019). The detailed results of the bypass seepage mixing/loading model were supplied as an Excel spreadsheet, and can be found in Garrett (2019c). Table 3.7.2-18 presents model results for all modeled chemical constituents for cells in the first groundwater cell along Donnelly Wash (cell DW-2) and the ultimate surface water cell (Gila River below Donnelly Wash), for model years 41, 100, and 245. This provides perspective on trends and expected conditions at the end of mining and in the long term. Table 3.7.2-18 also presents Arizona water quality standards and baseline chemistry for added perspective.

Figures M-22 through M-28 in appendix M illustrate model results for the seven constituents of concern.

Modeling results for Alternative 5 indicate the following:

- Modeling estimates that engineered seepage controls can recover 84 percent of total seepage. All levels of control (Levels 0 through 2) have been applied to Alternative 5 for the purposes of estimating the effects of tailings seepage on water quality.
- For all constituents, concentrations decrease with distance from the tailings storage facility, but increase over time.
- No chemical constituent are anticipated in concentrations above groundwater or surface water standards. Nitrate is present in concentrations above aquifer water quality standards, but this is due to background nitrate concentrations and not seepage from the facility. Note also that in year 245, selenium just reaches the aquifer water quality standard but is not above it.
- Sulfate and total dissolved solids are significant constituents in tailings seepage and can alter the potential use of downstream water resources, but do not have numeric standards. Over time, sulfate concentrations in groundwater closest to the tailings storage facility are expected to rise substantially above the 250 mg/L secondary standard to 594 mg/L (see appendix M, figure M-22).
- Most constituents increase in concentration in groundwater and surface water above existing baseline conditions.
- The practicability of adding seepage controls during operations is assessed in the following section.

Practicability for Additional Seepage Controls

The site-specific suite of engineered seepage controls designed for Alternative 5 is substantially more effective at controlling seepage than a fully lined facility with no other controls. The estimated loss through a full liner is about 1,400 acre-feet per year for a 5,900-acre facility (see Rowe (2012) and Newell and Garrett (2018d) for details of this estimate). This estimate is specifically for an engineered low-permeability liner as specified under Arizona BADCT; composite liners are able to reach better performance, but there are substantial logistical concerns about the ability to successfully install a full liner of any kind (see Newell and Garrett (2018d) for a summary of concerns).

Under the suite of engineered seepage controls considered (Levels 0 through 2), the entire PAG cell and about 300 acres of the NPAG facility would already use low-permeability layers which have similar permeabilities to the Arizona BADCT specifications. The comparison with a full liner illustrates the need for layered seepage controls, particularly downstream seepage collection dams and pumpback wells, to control seepage that would be generated from within the facility regardless of the foundation treatment.

Alternative 5 has substantial flexibility for adding other layers of seepage controls during operation as needed. The pumpback system for Level 2 seepage controls is not assumed to be operating at full capacity, and this would be an efficient way of increasing seepage capture as needed. The distance downstream to the Gila River offers opportunities for modified or expanded pumpback systems or physical barriers (grout curtains).

RAMIFICATIONS FOR LONG-TERM CLOSURE

Post-closure Water Quality, Seepage Rates, and Closure Timing

Modeling indicates that the concentrations of constituents of concern continue to increase over time, post-closure. Post-closure seepage rates are estimated to be 261 acre-feet per year (Kidner and Pilz 2019).

In the alternative design, Kidner and Pilz (2019) estimated during closure the facility would gradually drain down. The seepage collection ponds would remain in place and passively evaporate seepage, and the seepage extraction wells downstream would remain in place to control seepage as long as necessary. This time frame is estimated from 100 to 150 years (Kidner and Pilz 2019). Once the collection ponds can be closed, the closure plans call for encapsulating the accumulated sludge in the geomembrane and backfilling with soil to grade.

Financial Assurance for Closure and Post-closure Activities

The regulatory framework under the State of Arizona to require financial assurance for long-term closure activities is the same as described for Alternative 2. However, for the tailings facility, financial assurance requirements would be required by BLM, not the Forest Service.

Like the Forest Service, BLM also has regulatory authority to require financial assurance for closure activities, contained in their surface management regulations (43 CFR Subpart 3809). BLM considers that the financial assurance must cover the estimated cost as if BLM were hiring a third-party contractor to perform reclamation of an operation after the mine has been abandoned. The financial assurance must include construction and maintenance costs for any treatment facilities necessary to meet Federal and State environmental standards.

POTENTIAL IMPACTS ON IMPAIRED WATERS

Any discharges from Alternative 5 are downstream of any impaired waters.

PREDICTED REDUCTIONS IN ASSIMILATIVE CAPACITY

The calculated reductions in assimilative capacity are shown in table 3.7.2-12. For Alternative 5, the discharge of seepage into the Gila River uses more than 20 percent of the assimilative capacity for copper and selenium.

Alternative 6 – Skunk Camp

POTENTIAL WATER QUALITY IMPACTS FROM TAILINGS STORAGE FACILITY

Seepage Controls Incorporated into Design

Alternative 6 includes the following seepage controls, similar in nature to those described for Alternative 2. A conceptual diagram of the seepage controls is shown in figure 3.7.2-9. Table 3.7.2-19 summarizes how these are expected to be applied:

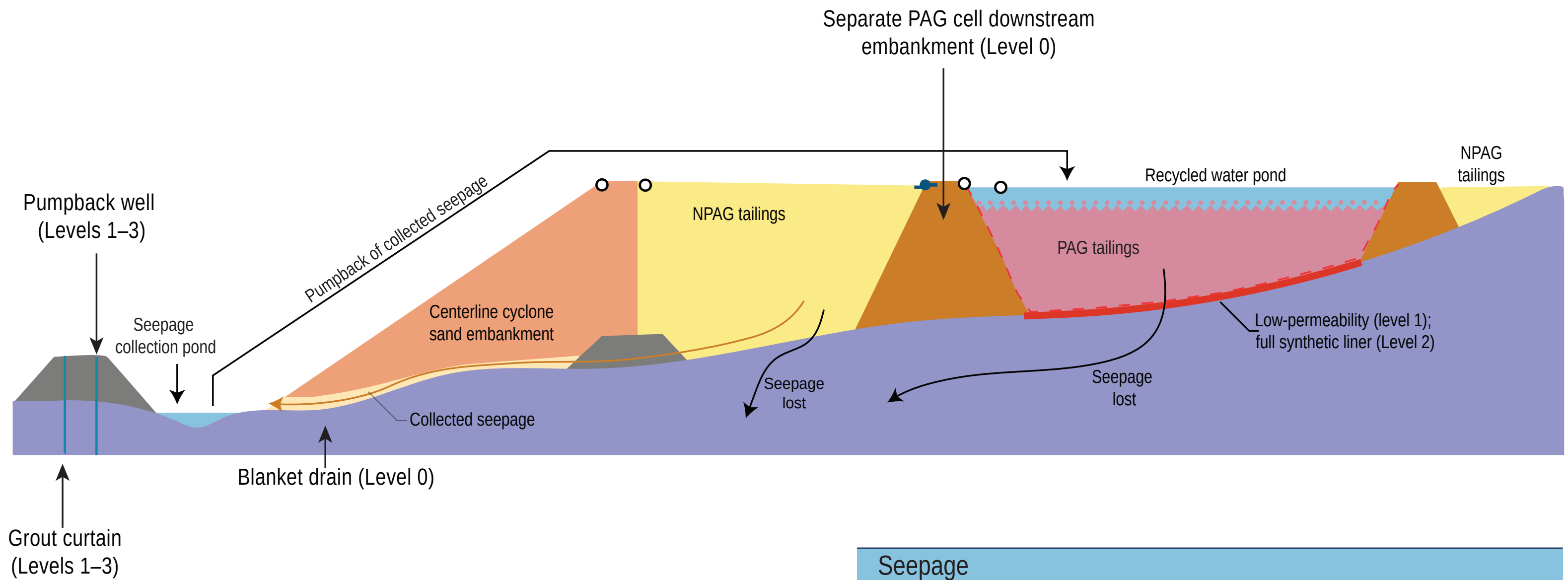
- Blanket drains beneath the embankment (Level 0), extending farther under the facility under Level 1 controls.
- A low-permeability layer under the entire separate PAG cell (Level 1).
- A single downstream seepage collection pond with grout curtains and a pumpback well system (Level 1). Under Level 2 the grout curtain and wells are deepened, and then under Level 3 they are deepened again.

Anticipated Effectiveness of Seepage Controls

For Alternative 6, total seepage estimates are based on two-dimensional steady-state finite element model (SEEP/W) (Klohn Crippen Berger Ltd. 2019c). The amount of lost seepage for Alternative 6 is estimated in two ways, both derived from the two-dimensional model. One estimate of lost seepage is the difference between the modeled seepage from the NPAG and PAG facilities, minus the amount of seepage modeled to be collected in the downstream seepage collection pond. A second estimate

Conceptual Cross Section of Entire Facility

Alternative 6 – Seepage Control Levels 0–3



Seepage Control Level	Grout Curtain/Cut-off	PumpBack Well
1	Depth of 70 feet	Depth of 20 feet
2	Depth of 100 feet	Depth of 70 feet
3	Depth of 100 feet	Depth of 100 feet

Figure 3.7.2-9. Alternative 6 seepage controls

Table 3.7.2-19. Effectiveness of Alternative 6 engineered seepage controls

Seepage Control Levels and Components	Uncaptured Seepage from Facility	Source
Uncontrolled seepage from tailings facility	1,870 acre-feet/year	Klohn Crippen Berger Ltd. (2019c)
Level 0 (seepage controls for geotechnical stability)		
- Centerline cyclone sand embankment - Blanket drain under embankment - Separate PAG and NPAG cells	Not explicitly modeled; incorporated into Level 1 modeling	N/A
Level 1		
- Blanket drain extends 100–200 feet underneath impoundment - Engineered low-permeability layer under entire PAG cell - Seepage collection ponds, with cut-offs, grout curtains, and pumpback wells; grout curtains extend to 70 feet (estimated base of alluvium); pumpback wells extend to 20 feet	580 to 660 acre-feet per year	Klohn Crippen Berger Ltd. (2019c)
Level 2		
- Grout curtains extended to 100 feet (estimated base of Gila Conglomerate); pumpback wells extend to 70 feet	270 to 370 acre-feet per year	Klohn Crippen Berger Ltd. (2019c)
Level 3		
- Pumpback wells extend to 100 feet	70 to 180 acre-feet per year	Klohn Crippen Berger Ltd. (2019c)

is derived directly from the modeled flux of water downstream of the seepage collection pond.

During operations, total seepage created by the tailings was estimated at 1,870 acre-feet per year (1,820 and 50 acre-feet per year of NPAG and PAG seepage, respectively) and lost seepage was modeled to be 580 to 660 acre-feet per year with Level 1 seepage controls, 270 to 370 acre-feet per year with Level 2 enhancements to the grout curtains and wells, and 200 to 260 acre-feet per year with all Level 3 enhancements.

Risk of Seepage Impacting Groundwater or Surface Water Quality

Modeled results for groundwater and surface water impacts are reported by Gregory and Bayley (2019). The detailed results of the bypass seepage mixing/loading model were supplied as an Excel spreadsheet and can be found in Garrett (2019c). Table 3.7.2-20 presents model results for all modeled chemical constituents in the first groundwater cell (cell DS-1) and the ultimate surface water cell (Gila River below Dripping Spring Wash), for model years 41, 100, and 245. This provides perspective on trends and expected conditions at the end of mining and in the long term. Table 3.7.2-20 also presents Arizona water quality standards and baseline chemistry for added perspective.

Figures M-29 through M-35 in appendix M illustrate model results for the seven constituents of concern.

Modeling results for Alternative 6 indicate the following:

- Modeling estimates that engineered seepage controls can recover 90 percent of total seepage. All levels of control (Levels 0 through 3) have been applied to Alternative 6 for the purposes of estimating the effects of tailings seepage on water quality.
- For all constituents, concentrations decrease with distance from the tailings storage facility, but increase over time.
- No chemical constituents are anticipated in concentrations above groundwater or surface water standards.
- Sulfate and total dissolved solids are significant constituents in tailings seepage and can alter the potential use of downstream water resources, but do not have numeric standards. Over time, sulfate concentrations in groundwater closest to the tailings storage facility are expected to rise slightly above the 250 mg/L secondary standard, to 385 mg/L (see appendix M, figure M-29).
- Most constituents increase in concentration in groundwater and surface water above existing baseline conditions.
- The practicability of adding seepage controls during operations is assessed in the following section. Resolution Copper is currently conducting further investigation at the site; this would inform the design of further controls. This investigation currently includes 17 test pits or drill holes, with an additional 15 possible locations within the tailings footprint.

Practicability for Additional Seepage Controls

The site-specific suite of engineered seepage controls designed for Alternative 6 is substantially more effective at controlling seepage than a fully lined facility with no other controls. The estimated loss through a full liner is about 960 acre-feet per year for a 4,000-acre facility (see Rowe (2012) and Newell and Garrett (2018d) for details of this estimate). This estimate is specifically for an engineered low-permeability liner as specified under Arizona BADCT; composite liners are able to reach better performance, but there are substantial logistical concerns about the ability to successfully install a full liner of any kind (see Newell and Garrett (2018d) for a summary of concerns).

Under the suite of engineered seepage controls considered (Levels 0 through 2), the entire PAG cell would already use low-permeability layers which have similar permeabilities to the Arizona BADCT specifications. The comparison to a full liner illustrates the need for layered seepage controls, particularly downstream seepage collection dams and pumpback wells, to control seepage that would be generated from within the facility, regardless of the foundation treatment.

Table 3.7.2-20. Seepage water quality modeling results for Alternative 6 (mg/L)

	Aquifer Water Quality Standard	Baseline Groundwater Quality (Skunk Camp Well*)	DS-1 Model Cell Year 41	DS-1 Model Cell Year 100	DS-1 Model Cell Year 245	Surface Water Standard for Most Restrictive Use	Baseline Surface Water Quality (Gila River below Dripping Spring Wash*)	Gila River below Dripping Spring Wash Modeled Surface Water Year 41	Gila River below Dripping Spring Wash Modeled Surface Water Year 100	Gila River below Dripping Spring Wash Modeled Surface Water Year 245
Constituents with Numeric Standards										
Antimony	0.006	0.00023	0.00091	0.00128	0.00162	0.030	0.00023	0.00024	0.00025	0.00025
Arsenic	0.05	0.0003	0.0003	0.0005	0.0011	0.030	0.00861	0.0086	0.0086	0.0086
Barium	2	0.0038	0.0073	0.0081	0.0078	98	0.0749	0.075	0.075	0.075
Beryllium	0.004	0.0017	0.00171	0.00171	0.00171	0.0053	0.0017	0.0017	0.0017	0.0017
Boron	–	0.026	0.076	0.100	0.109	1	0.196	0.197	0.197	0.197
Cadmium	0.005	0.00006	0.0011	0.0015	0.0014	0.0043	0.00006†	0.00008†	0.00009†	0.00009†
Chromium, Total	0.1	0.0020	0.0077	0.0098	0.0087	1	0.0020	0.0021	0.0021	0.0021
Copper	–	0.00165	0.038	0.051	0.044	0.0191	0.00207†	0.0026†	0.00291	0.0028†
Fluoride	4	0.232	0.78	0.96	0.87	140	1.0	1.04	1.04	1.04
Iron	–	0.056	0.0563	0.0564	0.0564	1	0.071	0.071	0.071	0.071
Lead	0.05	0.000140	0.00031	0.00040	0.00045	0.0065	0.00014†	0.00014†	0.00014†	0.00015†
Manganese	–	0.0034	0.122	0.170	0.156	10	0.029	0.031	0.032	0.032
Mercury	0.002	N/A	N/A	N/A	N/A	0.00001	N/A	N/A	N/A	N/A
Nickel	0.1	0.0023	0.015	0.020	0.022	0.1098	0.0023†	0.0025†	0.0026†	0.0026†
Nitrate	10	1.34	1.82	1.95	1.91	3,733.333	0.305	0.31	0.32	0.31
Nitrite	1	N/A	N/A	N/A	N/A	233.333	N/A	N/A	N/A	N/A
Selenium	0.05	0.0004	0.022	0.030	0.028	0.002	0.0004	0.0007	0.0009	0.0009
Silver	–	0.000061	0.0050	0.0069	0.0059	0.0147	0.000061	0.00014	0.00018	0.00016
Thallium	0.002	0.00008	0.00042	0.00053	0.00047	0.0072	0.000080	0.00009	0.00009	0.00009
Uranium	–	N/A	N/A	N/A	N/A	2.8	N/A	N/A	N/A	N/A
Zinc	–	0.224	0.445	0.538	0.518	0.2477	0.0050†	0.0085†	0.0103†	0.0099†
pH	–	N/A	N/A	N/A	N/A	6.5–9.0	N/A	N/A	N/A	N/A

continued

Table 3.7.2-20. Seepage water quality modeling results for Alternative 6 (mg/L) *(cont'd)*

	Aquifer Water Quality Standard	Baseline Groundwater Quality (Skunk Camp Well*)	DS-1 Model Cell Year 41	DS-1 Model Cell Year 100	DS-1 Model Cell Year 245	Surface Water Standard for Most Restrictive Use	Baseline Surface Water Quality (Gila River below Dripping Spring Wash*)	Gila River below Dripping Spring Wash Modeled Surface Water Year 41	Gila River below Dripping Spring Wash Modeled Surface Water Year 100	Gila River below Dripping Spring Wash Modeled Surface Water Year 245
Constituents without Numeric Standards										
Sulfate	–	54	196	365	385	–	100	102	105	105
Total Dissolved Solids	–	327	575	830	846	–	702	706	710	711

Notes: N/A = not analyzed in seepage modeling

Model data are not specific to total or dissolved fractions; for the purposes of comparison to surface water standards it can be assumed to apply to both.

* Assumed concentrations are based on single sample collected on 9 November 2018 and are therefore approximate.

† Standards are hardness dependent and were calculated using a hardness value of 242 mg/L $CaCO_3$ (from sample collected on 9 November 2018); see appendix N, table N-5, for details on how these standards were selected

Like Alternative 5, Alternative 6 has substantial flexibility for adding other layers of seepage controls during operations as needed. The distance downstream to the Gila River offers opportunities for modified or expanded pumpback systems or physical barriers (grout curtains).

RAMIFICATIONS FOR LONG-TERM CLOSURE

Post-closure Water Quality, Seepage Rates, and Closure Timing

Modeling indicates that the concentrations of constituents of concern continues to increase over time, post-closure. Post-closure seepage rates are estimated to be 200 to 260 acre-feet per year (Klohn Crippen Berger Ltd. 2019c). In the alternative design, Klohn Crippen Berger Ltd. (2018d) estimated that active closure would be required up to 20 years after the end of operations. Up to 5 years after closure, the recycled water pond still is present and therefore all engineered seepage controls could remain operational, with seepage pumped back to the tailings storage facility. After 5 years, the recycled water pond is no longer present. At this time the seepage collection ponds would be expanded to maximize evaporation, and then active water management (either enhanced evaporation or treatment for release) would take place until the ponds could passively evaporate all incoming seepage (estimated at 20 years). The sludge of concentrated metals and salts from evaporation would likely eventually require cleanup and handling as solid or hazardous waste.

Financial Assurance for Closure and Post-closure Activities

The regulatory framework under the State of Arizona to require financial assurance for long-term closure activities is the same as described for Alternative 2. However, Alternative 6 differs from the other alternatives because the tailings facility would not be located on lands managed by the Forest Service (Alternatives 2, 3, and 4) or BLM (Alternative 5). For Alternative 6, the Federal financial assurance mechanisms would not be applicable.

POTENTIAL IMPACTS ON IMPAIRED WATERS

As noted, the Gila River between the San Pedro River and Mineral Creek is currently considered impaired for suspended sediment concentrations. Given the stormwater controls put in place during operation and the long-term reclamation after closure, it is unlikely that Alternative 6 would contribute to suspended sediment in the Gila River.

PREDICTED REDUCTIONS IN ASSIMILATIVE CAPACITY

The calculated reductions in assimilative capacity are shown in table 3.7.2-12. For Alternative 6, the discharge of seepage into the Gila River uses more than 20 percent of the assimilative capacity for selenium.

Other Water Quality Concerns

PERSISTENCE OF PROCESSING CHEMICALS IN TAILINGS

In order to extract concentrated copper and molybdenum using flotation, Resolution Copper would add a series of substances or reagents during processing. If these substances were to persist in the processing water, they have the potential to be released to the environment along with seepage from the tailings storage facilities. Six reagents expected to be used in the processing facility were analyzed (Hudson 2018):

- AERO 8989. This substance renders the copper minerals hydrophobic, causing them to attach to air bubbles blown into the flotation tank. The copper-molybdenum concentrate froth then floats to the top of the tank and is skimmed off. The majority of the AERO 8989 exits the process with the copper-molybdenum concentrate. This concentrate gets thickened and separated into copper concentrate and molybdenum concentrate and sent off-site for additional processing. Water recovered from the concentrate thickeners is recycled back to the processing plant. While some small amounts may persist in the tailings

stream, there is no pathway for a substantial release of AERO 8989 to the environment.

- Diesel. Diesel acts similarly to AERO 8989 but for molybdenum minerals. Water recovered from the concentrate thickeners is recycled back to the processing plant. As with AERO 8989, while some small amounts may persist in the tailings stream, there is no pathway for a substantial release of diesel to the environment.
- Sodium isopropyl xanthate (SIPX) acts similarly to AERO 8989 and diesel but attaches to pyrite and sulfide minerals and renders them hydrophobic. SIPX is used later in the process, after copper and molybdenum concentrates have been removed, in order to separate the PAG and NPAG tailings streams. The majority of this reagent would enter the tailings storage facility with the PAG tailings stream. Any water recovered in the recycled water pond would potentially contain SIPX and would be recycled back to the processing plant. Some SIPX remains entrained with the PAG tailings and therefore has the potential to contribute to seepage water quality. The breakdown of SIPX yields xanthate and carbon disulfide as two major byproducts. Xanthate decomposes as well as adsorbs; depending on the temperature the half-life can range from less than 1 hour to almost 4 months (Eary 2018h). At the concentrations being considered and the likely temperatures, xanthate is unlikely to survive long enough to be detectable in any lost seepage. Most of the carbon disulfide generated is expected to be volatilized as tailings pass through the spigots and are deposited in the facility; in the atmosphere carbon disulfide decomposes to carbonyl sulfide, carbon monoxide, and sulfur dioxide. The carbon disulfide that remains decomposes with a half-life ranging from roughly 6 months to 1 year. Given that the transit times for seepage to reach aquifers is estimated in the range of decades (Groenendyk and Bayley 2018a), carbon disulfide is unlikely to survive long enough to be detectable in any lost seepage.
- Methyl isobutyl carbinol (MIBC). MIBC is used to lower the surface tension of the water, thus strengthening the air bubbles in the flotation tank. MIBC is used during concentration of copper and molybdenum and during separation of the PAG and NPAG tailings streams. Most MIBC would volatize, and the MIBC that remains degrades relatively quickly, at about 14 percent per day (Hudson 2018). MIBC is unlikely to survive long enough to be detectable in any lost seepage.
- Sodium hydrogen sulfide. This substance is used to separate copper from molybdenum concentrate by causing copper minerals to sink, while molybdenum concentrate remains in flotation. Water recovered from the concentrate thickeners is recycled back to the processing plant. There is no pathway for a substantial release of sodium hydrogen sulfide to the environment.
- Magnafloc 155. This substance is a flocculant, used to cause particles to combine into large groups and therefore settle more readily. This substance would be present in the PAG and NPAG tailings streams and in the copper and molybdenum concentrates. Specific information on the degradation of Magnafloc 155 is lacking. Some evidence exists that exposure to sunlight and physical processing are both likely to cause degradation. The potential for Magnafloc 155 to persist in tailings seepage is unclear, but as the purpose of using Magnafloc is to bind with solid particles it would not be expected to have substantial mobility.

TECHNOLOGICALLY ENHANCED NATURALLY OCCURRING RADIOACTIVE MATERIALS (TENORM)

The potential for the occurrence of natural radioactive materials in the ore deposit, the potential to concentrate those materials during processing, and the potential for these materials to affect tailings seepage were raised as potential concerns for the project. This topic was investigated by Resolution Copper (Duke 2019b), and further analyzed

by the Forest Service for the EIS. Full details of the analysis are contained in Newell and Garrett (2018d) and are summarized here.

Radioactive materials such as uranium, thorium, and radium occur naturally in the earth's crust and soil. In some cases, these materials can be concentrated by mining processes, leading to a concern that technologically enhanced naturally occurring radioactive materials (TENORM) could result in water quality concerns in seepage from the tailings storage facility.

The potential for this problem to occur was assessed based on analysis conducted on 5,987 samples of Resolution copper ore from 137 exploration boreholes, master ore composites, laboratory-simulated tailings samples, and background groundwater quality samples. When compared with common background levels, review of existing information at the site does not suggest the strong presence of naturally occurring radioactive materials above typical concentrations, although a small percentage (2 to 6 percent) of samples have exhibited concentrations above thresholds of concern.

Several past examples of TENORM have been documented in the vicinity of the project, including at the Magma Mine, Pinto Valley, and the Ray Mine. However, all of these were associated with acidic leaching and electrowinning. The Resolution Copper Project does not include any heap leaching, solvent extraction-electrowinning, or recycling of raffinate. The processes that historically have been documented with problems would not occur as part of this project.

With respect to the processing (flotation) that would be used during the Resolution Copper Project, site-specific locked cycle testing has simulated the effect of processing to potentially concentrate radioactive materials, and no concentrations are above any thresholds of concern for uranium, radium, and gross alpha activity.

PRESENCE OF ASBESTIFORM MINERALS

Similar to radioactive materials, the potential for asbestiform minerals to occur in the Resolution ore deposit and eventually end up in the tailings facility was raised as a possible concern. Resolution Copper investigated the overall occurrence of these minerals (Duke 2019a).

Asbestos is present in trace to minor amounts in the Resolution ore and development rock as fibrous forms of the amphibole minerals tremolite and actinolite, primarily tremolite. The general threshold for asbestos-containing material is more than 1 percent asbestos as determined by polarized light microscopy (40 CFR 61.141).

Abundances of tremolite and actinolite in the ore body were assessed from 992 samples from 110 exploration boreholes. Tremolite is consistently present (90 percent of samples), with the highest concentrations generally associated with skarn rock units. Abundance ranged from less than 0.01 to 24.24 percent by weight, with a mean of 0.27 percent by weight.

Resolution Copper has conducted two additional targeted studies. In 2006, 34 samples of development rock were submitted for bulk asbestos analysis. Of these, 85 percent of the samples did not contain detectable asbestiform minerals. All samples with detectable asbestiform minerals were associated with skarn rock units. In 2007, 53 samples specific to skarn rock units were submitted for bulk asbestos analysis. Of these, 66 percent of the samples did not contain detectable asbestiform minerals; the remaining abundances ranged from 0.5 to 4.0 percent by weight.

These analyses indicate that asbestiform minerals are present in the ore deposit, but on average the percentage is below the threshold for concern. However, the block caving is not conducted on the ore deposit as a whole, but panel by panel. When viewed on a panel-by-panel basis, overall asbestiform minerals are not anticipated to exceed 0.1 percent by weight.

Cumulative Effects

The Tonto National Forest identified the following reasonably foreseeable future actions as likely, in conjunction with development of the Resolution Copper Mine, to contribute to cumulative impacts on groundwater or surface water quality. As noted in section 3.1, past and present actions are assessed as part of the affected environment; this

section analyzes the effects of any RFFAs, to be considered cumulatively along with the affected environment and Resolution Copper Project effects.

- *Ripsey Wash Tailings Project.* Mining company ASARCO is planning to construct a new tailings storage facility to support its Ray Mine operations. The environmental effects of the project were analyzed in an EIS conducted by the USACE and approved in a ROD issued in December 2018. As approved, the proposed tailings storage facility project would occupy an estimated 2,574 acres and be situated in the Ripsey Wash watershed just south of the Gila River approximately 5 miles west-northwest of Kearny, Arizona, and would contain up to approximately 750 million tons of material (tailings and embankment material). ASARCO estimates a construction period of 3 years and approximately 50 years of expansion of the footprint of the tailings storage facility as slurry tailings are added to the facility, followed by a 7- to 10-year period for reclamation and final closure. Results of geochemistry characterization and testing on the proposed tailings and borrow materials reveal a low potential to impact groundwater or surface water with the design and operational safeguards proposed for the facility. Kinetic testing revealed a low potential for any acid generation from tailings materials and confirmed that alluvium materials to be used for construction activities are not acid-generating. The meteoric water mobility testing on both tailings and alluvium material also revealed that possible dissolution and mobilization of minerals from these materials are low. The facility is located close to the Gila River, downstream of Dripping Spring Wash (where Alternative 6 discharges would occur) and upstream of Donnelly Wash (where Alternative 5 discharges would occur). Any pollutant load to the Gila River from the facility, even if within permit limits, would cumulatively affect water quality in the Gila River in combination with Resolution Copper Project impacts for Alternative 5 or 6.
- *Ray Land Exchange and Proposed Plan Amendment.* ASARCO is also seeking to complete a land exchange with the BLM by which the mining company would gain title to approximately 10,976 acres of public lands and federally owned mineral estate located near ASARCO's Ray Mine in exchange for transferring to the BLM approximately 7,304 acres of private lands, primarily in northwestern Arizona. It is known that at some point ASARCO wishes to develop a copper mining operation in the "Copper Butte" area west of the Ray Mine. Specific pollutant discharges are not yet known, but given the location of this future mining activity, any impacts on water quality could potentially be cumulative with Resolution Copper Project–related impacts on the Gila River for Alternatives 5 and 6.
- *Pinto Valley Mine Expansion.* The Pinto Valley Mine is an existing open-pit copper and molybdenum mine located approximately 8 miles west of Miami, Arizona, in Gila County. Pinto Valley Mining Corporation is proposing to expand mining activities onto an estimated 1,011 acres of new disturbance (245 acres on Tonto National Forest land and 766 acres on private land owned by Pinto Valley Mining Corporation) and extend the life of the mine to 2039. The primary concern with regard to water quality centers around the potential for geochemical seepage or runoff from tailings or other mine facilities into groundwater and surface waters within the Pinto Creek watershed. This is in a different watershed from any Resolution Copper Project–related impacts and would not cumulatively affect this resource.

Mitigation Effectiveness

The Forest Service is in the process of developing a robust mitigation plan to avoid, minimize, rectify, reduce, or compensate for resource impacts that have been identified during the process of preparing this EIS. Appendix J contains descriptions of mitigation concepts being considered and known to be effective, as of publication of the DEIS. Appendix J also contains descriptions of monitoring that would be

needed to identify potential impacts and mitigation effectiveness. As noted in chapter 2 (section 2.3), the full suite of mitigation would be contained in the FEIS, required by the ROD, and ultimately included in the final GPO approved by the Forest Service. Public comment on the DEIS, and in particular appendix J, will inform the final suite of mitigations.

At this time, no mitigation measures have been identified that would be pertinent to groundwater and surface water quality. Applicant-committed environmental protection measures have already been detailed elsewhere in this section, will be a requirement for the project, and have already been incorporated into the analysis of impacts.

UNAVOIDABLE ADVERSE EFFECTS

The applicant-committed environmental protection measures for stormwater control would effectively eliminate any runoff in contact with ore or tailings. There are no anticipated unavoidable adverse effects associated with the quality of stormwater runoff.

Seepage from the tailings storage facilities has a number of unavoidable adverse effects. In all cases, the tailings seepage adds a pollutant load to the downstream environment, including downstream aquifers and downstream surface waters where groundwater eventually daylights. The overall impact of this seepage varies by alternative. Alternatives 2, 3, and 4 all either have anticipated impacts on water quality or have a high risk to water quality because of the extreme seepage control measures that must be implemented, and the relative inflexibility of adding more measures as needed, given the proximity to Queen Creek.

Alternatives 5 and 6 are located at the head of larger alluvial aquifers with some distance downstream before the first perennial water (the Gila River). Adverse effects are not anticipated from these alternatives, and in addition these locations offer more flexibility in responding to potential problems with additional seepage controls.

Other Required Disclosures

SHORT-TERM USES AND LONG-TERM PRODUCTIVITY

The use of the alternative sites for tailings storage represents a short-term use, with disposal happening over the operational life of the mine. However, the seepage from the tailings facilities would continue for much longer, with potential management anticipated being required over 100 years in some cases. While seepage persists, the long-term productivity of the downstream aquifers and surface waters could be impaired for some alternatives.

Irreversible and Irretrievable Commitment of Resources

The potential impacts on water quality from tailings seepage would cause an irretrievable commitment of water resources downstream of the tailings storage facility, lasting as long as seepage continued. Eventually the seepage amount and pollutant load would decline, and water quality conditions would return to a natural state. This may take over 100 years to achieve in some instances.

While long lived, the impacts on water quality would not be irreversible, and would eventually end as the seepage and pollutant load declined.

3.7.3 Surface Water Quantity

3.7.3.1 Introduction

Perennial streams and springs are relatively rare in the area but do exist (see discussion in Section 3.7.1, Groundwater Quantity and Groundwater-Dependent Ecosystems). For the most part, surface waters in the area consist of dry washes or ephemeral channels that flow only in response to moderate- to high-intensity rainfall events. Water that flows in these washes and streams due to runoff from rainfall events reflects conditions in the upstream watershed—the geographic area that contributes to flow in the stream—and these flows could change if the upstream watershed changes.

The project would cause two major changes to these watersheds. Once the subsidence area develops at the surface, precipitation falling within this area would no longer report to the downstream stream network, potentially reducing runoff reaching both Devil's Canyon and Queen Creek.

In addition to the loss of runoff from the subsidence area, precipitation falling on or within the tailings storage facility would also be unavailable to downstream washes. All the tailings alternatives are designed to allow any runoff from upstream in the watershed to flow around the facility and continue flowing downstream. However, for the slurry tailings facilities (Alternatives 2, 3, 5, and 6), the top of the tailings facility is managed as a pond to allow process water to be recycled. Any rain falling within the bounds of a slurry facility, including the seepage recovery ponds at the downstream toe of the tailings embankment, is retained and recycled.

Alternative 4 – Silver King is the sole filtered tailings alternative and is different from the slurry alternatives. Filtered tailings must be managed to shed, not retain, water. However, because rain that sheds off the filtered tailings has contacted tailings, it must be collected downstream and not released to the environment during operations. The overall result for the filtered tailings alternative is the same as for the slurry alternatives—less surface water reporting downstream.

This section analyzes the reduction in streamflow caused by each of the alternatives, in terms of both total volume and peak flows during flood events. This section also analyzes the impacts that would be expected on sediment yields and stream geomorphology, impacts on water quality from sediment changes, impacts on jurisdictional waters of the U.S. (related to the CWA Section 404 program), impacts on floodplains, and impacts on wetlands (related to Executive Order 11990). Some aspects of the analysis are briefly summarized in this section. Additional details not included are captured in the project record (Newell and Garrett 2018d).

3.7.3.2 Analysis Methodology, Assumptions, and Uncertain and Unknown Information

Analysis Area

The analysis area for surface water quantity includes the Queen Creek, Devil's Canyon, Dripping Spring Wash, and Donnelley Wash drainages: all of these watercourses are tributaries of the Gila River. The primary focus of the analysis is on waters downstream of areas that would be directly impacted by the mine, including by the subsidence area. Since the entire watershed affects flow in these areas, the analysis area also includes the larger watershed of these channels, as shown on figure 3.7.3-1. Specific analysis locations used to assess changes in streamflow are also shown on figure 3.7.3-1.

Approach

Two separate modeling approaches were used to assess how the subsidence area and tailings storage facilities would affect runoff. Flood flows are often characterized by the "return period," i.e., a 2-year or 20-year flood event, which is just another way of expressing the probability of an event occurring. For example, a 2-year event has a 50 percent chance of occurring for any given storm, and a 20-year event has a 5 percent chance of occurring for any given storm. An approach developed by the USGS was used to analyze how reduced watershed

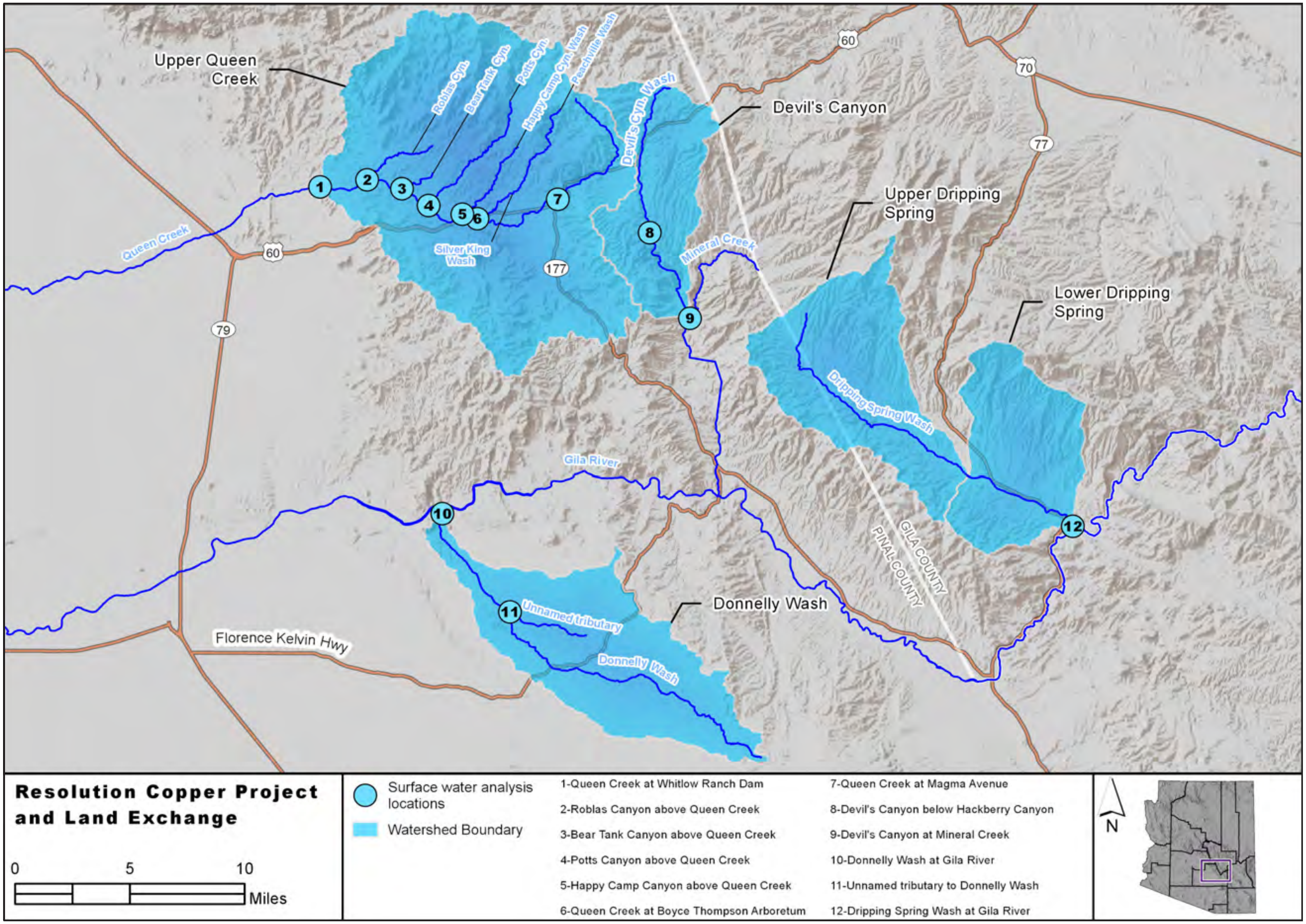


Figure 3.7.3-1. Surface water quantity analysis area

area would affect peak flood flows with different return periods (Lehman 2017, 2018).

In addition to changes to individual flood events, the loss of watershed area also would affect the overall volume of water flowing through a wash and available to wildlife, vegetation, and surface water users. A "monthly water balance" modeling approach was used to assess reductions in the overall volumes of water available to the natural system due to the subsidence area and the tailings storage facilities (BGC Engineering USA Inc. 2018c). Prior to use, the monthly water balance model was first calibrated using data from Pinto Creek. The modelers found Devil's Canyon, Queen Creek, and Dripping Spring Wash watersheds to be similar in nature to Pinto Creek, but note that Donnelly Wash is substantially different (less-steep gradient), which may introduce some uncertainty into the modeling (BGC Engineering USA Inc. 2018c). For a further overview of these two modeling approaches, and for additional citations for further information, see Newell and Garrett (2018d).

For much of the project area, 100-year floodplains have not been mapped, but have been estimated based on available geological mapping (Newell and Garrett 2018d).

3.7.3.3 Affected Environment

Relevant Laws, Regulations, Policies, and Plans

A number of laws, regulations, and policies are pertinent to surface water quantity and are summarized in Newell and Garrett (2018d). Two of these are worth noting here.

As discussed in section 1.5.3, the USACE would rely on this EIS to support issuance of a permit under Section 404 of the CWA, which regulates dredge and fill within waters of the U.S. Part of the USACE permitting responsibility would be to identify jurisdictional waters of the U.S., identify which alternative represents the least environmentally damaging practicable alternative, and to require adequate mitigation to compensate for impacts on waters of the U.S. This section summarizes the potentially jurisdictional waters associated with each alternative, and considers the mitigation proposed to compensate for impacts on waters of the U.S.

Primary Legal Authorities Relevant to the Surface Water Quantity Analysis

- Clean Water Act (Section 404)
- Executive Order 11988—Occupancy and modification of floodplains; Executive Order 11990—Destruction, loss, or degradation of wetlands
- Pinal County Floodplain Management Ordinance

In Arizona, jurisdictional waters of the U.S. often include both ephemeral washes and wetlands areas. Both types of jurisdictional waters are defined by specific technical guidance from the USACE. The Forest Service also considers wetlands under Executive Order 11990, which directs Federal agencies to minimize the destruction, loss, or degradation of wetlands and to preserve and enhance the natural and beneficial value of wetlands in carrying out programs that affect land use. Wetlands considered under Executive Order 11990 are not strictly defined and differ from the jurisdictional waters considered for a 404 permit. This section separately considers wetlands under Executive Order 11990, relying on the National Wetlands Inventory as a data source.

DOCUMENTATION SPECIFIC TO CLEAN WATER ACT SECTION 404 PERMIT ISSUANCE

Issuance of a permit under Section 404 of the CWA requires submittal of a permit application and supporting documentation to the USACE. Fundamental to those regulations is the principle that dredged or fill material cannot be discharged into the aquatic ecosystem unless it can be demonstrated that there is no less environmentally damaging practicable

alternative that achieves an applicant's project purpose. In other words, only the least environmentally damaging practicable alternative can be permitted (40 CFR 230.10(a)).

The 404 permitting process includes submittal of a document called a "404(b)1 alternatives analysis." The purpose of the 404(b)1 alternatives analysis is to identify the least environmentally damaging practicable alternative. To determine the least environmentally damaging practicable alternative, each practicable alternative for the proposed mine must be fully analyzed in the 404(b)1 alternatives analysis to assess the relative magnitude of project impacts, including direct, secondary, and cumulative impacts.

Most of the impacts considered under the USACE process are identical to those considered in this EIS, describing physical effects on the environment caused by the mine. However, some impacts considered under the USACE process are specific only to that permitting process, which may have a different scope of analysis. For example, the analysis in sections 3.7.1 and 3.7.3 of this EIS considers the overall physical impacts on streams and the riparian ecosystems associated with streams, but in doing so does not look at acreage as a measure of impact. In contrast, the calculation of the exact acreage of impacts on jurisdictional waters (both direct and indirect) is a very specific requirement of the 404(b)1 alternatives analysis.

Because of these differences, the 404(b)1 alternatives analysis is a document strongly related to the EIS, but also separate. The 404(b)1 alternatives analysis submitted to the USACE by Resolution Copper for the preferred alternative is attached to the EIS as appendix C.

An additional requirement of the USACE process is for compensatory mitigation to offset the impacts on jurisdictional waters. Similar to the 404(b)1 alternatives analysis, this mitigation is pertinent to both the EIS and the USACE process but is handled differently in each. In the EIS, the focus is on whether mitigation would be effective at addressing impacts of any resources, and if so, what residual impacts would remain. This is often a qualitative assessment. For the USACE process, the calculations of the amount of mitigation required are quantitative and formulaic with specific acreage multipliers used for different types of impacts. The conceptual compensatory mitigation plan submitted to the USACE by Resolution Copper for the preferred alternative is attached to the EIS as appendix D.

Table 3.7.3-1. Watershed characteristics

Watershed	Minimum Elevation (feet amsl)	Maximum Elevation (feet amsl)	Mean Elevation (feet amsl)	Average Slope (percent)	Area (square miles)
Devil's Canyon	2,240	5,610	4,240	36	36
Dripping Spring Wash	2,025	7,645	3,670	33	117
Queen Creek	2,135	5,610	3,225	31	143
Donnelly Wash	1,615	3,900	2,900	7	60

Note: Watershed characteristics derived from USGS StreamStats application (U.S. Geological Survey 2018d)

The effectiveness of the conceptual mitigation is assessed in this section of the EIS in a manner similar to other resources and does not reflect USACE calculations or analysis.

Existing Conditions and Ongoing Trends

REGIONAL HYDROLOGIC SETTING

The analysis area includes the Queen Creek, Devil's Canyon, Dripping Spring Wash, and Donnelly Wash drainages: all of these watercourses are tributaries of the Gila River, as shown in figure 3.7.3-1. Watershed characteristics of these drainages are summarized in table 3.7.3-1.

QUEEN CREEK AND DEVIL'S CANYON WATERSHEDS (SUBSIDENCE AREA AND ALTERNATIVES 2, 3, AND 4)

The western part of the analysis area is drained by Queen Creek, which arises in the highlands around the Pinal Mountains and flows past Oak Flat and through the town of Superior. Queen Creek ultimately flows to Whitlow Ranch Dam, about 11 miles west of Superior. The dam is an ungated flood risk–management structure that was constructed in 1960 to reduce the risk of downstream flood damage to farmland and the communities of Chandler, Gilbert, Queen Creek, and Florence Junction. The dam includes a diversion structure to satisfy local water rights.

As discussed in Section 3.7.1, Groundwater Quantity and Groundwater-Dependent Ecosystems, Queen Creek is primarily ephemeral but exhibits perennial flow downstream of the town of Superior wastewater treatment plant, both from effluent and groundwater discharges from a nearby mine pit.

The ore body is located approximately 4,500–7,000 feet beneath Oak Flat in the upper Queen Creek basin. Devil's Canyon is located to the immediate east of Oak Flat with its headwaters located north of U.S. 60. Devil's Canyon cuts through the Apache Leap Tuff, forming a steep-sided canyon that flows in a southerly direction for approximately 9 miles. Devil's Canyon discharges into the reservoir of Big Box Dam. Mineral Creek, to the immediate east of Devil's Canyon, also discharges into the reservoir. Big Box Dam was constructed to divert flows from Devil's Canyon and Mineral Creek around the Ray Mine and into the Gila River. As discussed in section 3.7.1, much of upper Devil's Canyon is ephemeral, where runoff is driven by rainfall events. However, there are several perennial reaches that are sustained either by shallow, recharged groundwater systems or a regional groundwater system that discharges to the surface via seeps and springs.

The subsidence area would affect portions of the watershed for Queen Creek and Devil's Canyon, and the tailings storage facilities for Alternatives 2, 3, and 4 would affect tributaries to Queen Creek.

GILA RIVER WATERSHED (ALTERNATIVES 5 AND 6)

Alternative 5 – Peg Leg would impact Donnelly Wash, which flows north to join the Gila River downstream of Mineral Creek. Donnelly Wash flows through an alluvial valley and has more gentle slope gradients, compared with the other watersheds. The main stem channel of Donnelly Wash is entirely ephemeral, with no known perennial reaches.

Alternative 6 – Skunk Camp would impact Dripping Spring Wash. Dripping Spring Wash is located in the eastern part of the analysis area. Dripping Spring Wash flows to the southeast for approximately 18 miles before discharging into the Gila River downstream of the Coolidge Dam. The main stem channel of Dripping Spring Wash is entirely ephemeral, with no known perennial reaches.

Both Alternatives 5 and 6 would also affect flow to the Gila River itself, which is perennial between Coolidge Dam and Florence.

CLIMATE CONDITIONS

The climate of the project area is generally arid to semi-arid. Topography influences the spatial distribution of precipitation, being lowest in the valley bottoms (average annual totals of approximately 13 inches in the vicinity of Whitlow Ranch Dam), and greatest in the upper elevations of the Queen Creek watershed (26 inches). There are two separate rainfall seasons. The first occurs during the winter from November through March, when the area is subjected to occasional storms from the Pacific Ocean. The second rainfall period occurs during the July and August "monsoon" period when Arizona is subjected to widespread thunderstorm activity whose moisture supply originates in the Gulf of Mexico and Pacific Ocean.

Precipitation typically occurs as high-intensity, short-duration storms during the summer monsoon, and longer term storms of more moderate intensity that occur during the winter months. Summer storms, coupled with relatively impervious land surfaces, sparse vegetation, and steep topographic gradients, result in rapid increases in streamflow. Winter rains tend to produce runoff events of longer duration and with higher

maximum flows than summer rains. This is a result of higher rainfall totals and wetter antecedent moisture conditions that tend to prevail in the winter months due to a significantly lower evapotranspiration demand. These wetter conditions result in less near-surface storage capacity in the winter and a larger proportion of any given rain event runs off rather than infiltrating. Regional gaging stations indicate that a majority of runoff occurs during the winter months (December to March) when evaporation rates are at a minimum.

Climate trends suggest that runoff could decrease in the future due to increased temperatures and reduced precipitation. Average temperatures in Arizona have increased about 2°F in the last century (U.S. Environmental Protection Agency 2016). In the Lower Colorado River basin, the annual mean and minimum temperature have increased 1.8°F–3.6°F for the time period 1900–2002, and data suggest that spring minimum temperatures for the same time period have increased 3.6°F–7.2°F (Dugan 2018). Annual average temperatures are projected to rise by 5.5°F to 9.5°F by 2070–2099, with continued growth in global emissions (Melillo et al. 2014).

While future projected temperature increases are anticipated to change mean annual precipitation to a small degree, the majority of changes to annual flow in the Lower Colorado River basin are related to changes in runoff timing. Increased temperatures are expected to diminish the accumulation of snow and the availability of snowmelt, with the most substantial decreases in accumulation occurring in lower elevation portions of the basin where cool season temperatures are most sensitive to warming (Dugan 2018).

Most precipitation falling within the watershed either evaporates or is transpired by vegetation, either from shallow surface soils (approximately 96 percent of precipitation) or along stream drainages and areas where the groundwater is relatively close to the surface and directly available to trees and shrubs (approximately 1 percent of precipitation). The remainder recharges to groundwater or leaves the basin as surface runoff (Montgomery and Associates Inc. 2018).[55]

3.7.3.4 Environmental Consequences of Implementation of the Proposed Mine Plan and Alternatives

Alternative 1 – No Action

Under the no action alternative, impacts on surface water runoff from the Resolution Copper Project and associated activities would not occur. However, impacts on a number of springs because of groundwater drawdown would occur under the no action alternative, as analyzed and discussed in section 3.7.1.

Impacts Common to All Action Alternatives

Table 3.7.3-2 summarizes locations where changes in average monthly and annual streamflow quantity were quantified for each the identified alternatives (BGC Engineering USA Inc. 2018c). Potential changes in streamflow have also been quantified for peak instantaneous flood flows and flows with durations of 1, 3, 7, 15, and 30 days (Lehman 2017, 2018). These changes in streamflow discharge-duration-frequency were assessed for annual exceedance probability (AEP) at 50, 20, 10, 4, 2, 1, 0.5, and 0.2 percent levels.

Streamflow discharge-duration-frequency analysis provides a detailed look at the dynamics of a stream under many conditions, and the full comparison is available for review (Newell and Garrett 2018d). For purposes of comparison in the EIS, two values from the discharge-duration-frequency analysis were selected to represent impacts at each location. The values selected are those that represent the peak instantaneous and the 30-day streamflows, each with a 50 percent probability of exceedance. The return period was selected because it represents flows that happen with relative frequency. The short duration (peak instantaneous streamflow) was selected to represent short, intense ephemeral flows that occur, typical of monsoon events. The long duration (30-day streamflow) was selected to represent streamflow

55. These percentages were calculated specifically for the Queen Creek watershed but in general would expect to be similar to the other watersheds in the analysis area, which are at similar elevations, with similar climate, and similar topography.

Table 3.7.3-2. Watershed locations where changes in streamflow for the project EIS action alternatives were analyzed

Location	Drainage Area (square miles)	Action Alternative
Devil's Canyon – downstream of confluence with Hackberry Canyon, roughly DC-8.1C.	19.0	All
Devil's Canyon – *confluence with Mineral Creek*	35.8	All
Queen Creek – *at Magma Avenue Bridge*	10.4	All
Queen Creek – at Boyce Thompson Arboretum	27.9	All
Queen Creek – *Upstream of Whitlow Ranch Dam*	143.0	All
Potts Canyon* – confluence with Queen Creek	18.1	Alternative 4
Happy Canyon* – confluence with Queen Creek	4.2	Alternative 4
Silver King Wash* – confluence with Queen Creek	6.7	Alternative 4
Roblas Canyon† – confluence with Queen Creek	10.2	Alternative 2, Alternative 3
Bear Tank Canyon† – confluence with Queen Creek	4.9	Alternative 2, Alternative 3
Unnamed Wash – *confluence with Gila River*	7.1	Alternative 5
Donnelly Wash – *confluence with Gila River*	59.9	Alternative 5
Gila River at Donnelly Wash	18,011	Alternative 5
Dripping Spring Wash – confluence with Gila River	117	Alternative 6
Gila River at Dripping Spring Wash	12,866	Alternative 6

Note: See process memorandum for more information on differences between analysis points (Newell and Garrett 2018d).
* Northern tributary impacted by Alternative 4 tailings storage facility.
† Northern tributary impacted by Alternative 2 and Alternative 3 tailings storage facility.

occurring over longer periods but at lesser volume, more typical of conditions affected by baseflow.

The locations analyzed by BGC Engineering USA Inc. (2018c) and Lehman (2017, 2018) differ slightly—coincident analysis locations are identified in italic font in table 3.7.3-2.

The total area of watershed removed from the system of each of the alternatives is summarized in table 3.7.3-3. These footprints reference the total watershed area where water losses would occur, either due to contact water being collected (tailings storage facilities or West Plant Site) or from the subsidence area.

Table 3.7.3-3. Watershed area lost for each mine component

Mine Component	Area of Watershed Lost (square miles)
Subsidence area – Queen Creek	1.76
Subsidence area – Devil's Canyon	0.94
West Plant Site	1.40
Near West tailings storage facility – Alternatives 2 and 3	6.90
Silver King tailings storage facility – Alternative 4	6.32
Peg Leg tailings storage facility – Alternative 5	11.88
Skunk Camp tailings storage facility – Alternative 6	12.15

EFFECTS OF THE LAND EXCHANGE

The land exchange would have effects on surface water quantity.

The Oak Flat Federal Parcel would leave Forest Service jurisdiction. Several surface waters are located on the Oak Flat Federal Parcel, including Rancho Rio Canyon, Oak Flat Wash, and Number 9 Wash, and the parcel also is a portion of the watershed feeding both Queen Creek and Devil's Canyon. The role of the Tonto National Forest under its primary authorities in the Organic Administration Act, Locatable Regulations (36 CFR 228 Subpart A), and Multiple-Use Mining Act is to ensure that mining activities minimize adverse environmental effects on NFS surface resources; this includes these surface waters. The removal of the Oak Flat Federal Parcel from Forest Service jurisdiction negates the ability of the Tonto National Forest to regulate effects on these resources.

The offered lands parcels would enter either Forest Service or BLM jurisdiction. A number of ephemeral washes and perennial water features are located on these lands:

- Tangle Creek. Tangle Creek is an intermittent or perennial tributary to the Verde River and bisects the parcel. It includes associated riparian habitat with mature hackberry, mesquite, ash, and sycamore trees.
- Turkey Creek. Features of the Turkey Creek Parcel include Turkey Creek, which is an intermittent or perennial tributary to Tonto Creek and eventually to the Salt River at Roosevelt Lake. Riparian vegetation occurs along Turkey Creek with cottonwood, locus, sycamore, and oak trees.
- Cave Creek. Features of the Cave Creek Parcel include Cave Creek, an ephemeral to intermittent tributary to the Agua Fria River, with some perennial reaches in the vicinity of the parcel.
- East Clear Creek. Features of the East Clear Creek Parcel include East Clear Creek, a substantial perennial tributary to the Little Colorado River. Riparian vegetation occurs along East Clear Creek, including boxelder, cottonwood, willow, and alder trees.
- Lower San Pedro River. Features of the Lower San Pedro River Parcel include the San Pedro River and several large ephemeral tributaries (Cooper, Mammoth, and Turtle Washes). The San Pedro River itself is ephemeral to intermittent along the 10-mile reach that runs through the parcel; some perennial surface water is supported by an uncapped artesian well. The San Pedro is one of the few remaining free-flowing rivers in the Southwest and it is recognized as one of the more important riparian habitats in the Sonoran and Chihuahuan Deserts. The riparian corridor in

the parcel includes more than 800 acres of mesquite woodlands that also features a spring-fed wetland.

- Appleton Ranch. The Appleton Ranch Parcels are located along ephemeral tributaries to the Babocomari River (Post, Vaughn, and O'Donnell Canyons). Woody vegetation is present along watercourses as mesquite bosques, with very limited stands of cottonwood and desert willow.
- Small ephemeral washes and unnamed drainages are associated with the Apache Leap South Parcel or the Dripping Springs Parcel.

Specific management of surface water resources on the offered lands would be determined by the agencies, but in general when the offered lands enter Federal jurisdiction, these surface waters would be afforded a level of protection they currently do not have under private ownership.

EFFECTS OF FOREST PLAN AMENDMENT

The Tonto National Forest Land and Resource Management Plan (1985b) provides guidance for management of lands and activities within the Tonto National Forest. It accomplishes this by establishing a mission, goals, objectives, and standards and guidelines. Missions, goals, and objectives are applicable on a forest-wide basis. Standards and guidelines are either applicable on a forest-wide basis or by specific management area.

A review of all components of the 1985 Forest Plan was conducted to identify the need for amendment due to the effects of the project, including both the land exchange and the proposed mine plan (Shin 2019). A number of standards and guidelines (22) were identified applicable to management of surface water resources. None of these standards and guidelines were found to require amendment because of the proposed project, on either a forest-wide or management area–specific basis. For additional details on specific rationale, see Shin (2019).

SUMMARY OF APPLICANT-COMMITTED ENVIRONMENTAL PROTECTION MEASURES

A number of environmental protection measures are incorporated into the design of the project that would act to reduce potential impacts on surface water quantity. These are non-discretionary measures and their effects are accounted for in the analysis of environmental consequences.

In the GPO, Resolution Copper has committed to various measures to reduce impacts on surface water quantity:

- To the extent practicable, stormwater flows upgradient of the facilities would be diverted around the disturbed areas and returned to the natural drainage system;
- As much water as possible would be recycled for reuse;
- Permanent diversion channels would be designed for operations and closure; and
- Runoff from roads, buildings, and other structures would be handled through best management practices, including sediment traps, settling ponds, berms, sediment filter fabric, wattles, etc.

IMPACTS ON SURFACE RUNOFF AND STREAMFLOW

The proposed block-cave mining operation would result in the formation of a subsidence area at the surface. This subsidence area is estimated to cover an area of 2.7 square miles within the Queen Creek and Devil's Canyon watersheds. Once fully formed, precipitation within the subsidence area footprint would not be expected to report as runoff to either Queen Creek or Devil's Canyon, resulting in a decrease in streamflow in both drainages. Tables 3.7.3-4 and 3.7.3-5 summarize expected changes in average monthly streamflow at two locations on Devil's Canyon and three locations on Queen Creek. These tables also show the peak instantaneous and 30-day (50 percent exceedance) streamflows for Queen Creek at Magma Avenue and for Devil's Canyon at Mineral Creek. Note that tables 3.7.3-4 and 3.7.3-5 only reflect streamflow losses from mine components common to all action

Table 3.7.3-4. Estimated changes in average monthly streamflow and peak flood flows common to all action alternatives – Devil's Canyon

	DC-8.1C			Mineral Creek Confluence		
Month	**Existing (cfs)**	**Proposed (cfs)**	**Decrease (%)**	**Existing (cfs)**	**Proposed (cfs)**	**Decrease (%)**
January	13.73	13.01	−5.3	21.97	21.25	−3.3
February	11.23	10.61	−5.6	17.33	16.71	−3.6
March	6.60	6.25	−5.3	10.38	10.04	−3.4
April	1.64	1.56	−5.1	2.47	2.38	−3.4
May	0.48	0.45	−5.4	0.73	0.71	−3.5
June	0.17	0.17	−5.3	0.27	0.26	−3.4
July	0.53	0.48	−8.2	0.84	0.79	−5.2
August	1.36	1.27	−7.2	2.18	2.09	−4.5
September	1.18	1.09	−7.5	1.98	1.89	−4.5
October	1.04	0.97	−6.5	1.75	1.68	−3.9
November	1.96	1.84	−5.9	3.22	3.11	−3.6
December	5.32	5.04	−5.4	8.48	8.19	−3.4
Average	**3.74**	**3.53**	**−5.6**	**5.92**	**5.71**	**−3.5**
Peak instantaneous streamflow (50% exceedance)	–	–	–	666	657	−1.4
30-day streamflow (50% exceedance)	–	–	–	13.9	13.6	−2.2

Sources: BGC Engineering (2018c); Lehman (2018)

Notes: Numbers have been rounded for presentation.

cfs = cubic feet per second

Table 3.7.3-5. Estimated changes in average monthly streamflow and peak flood flows common to all action alternatives – Queen Creek

	Queen Creek at Magma Avenue			Queen Creek at Boyce Thompson Arboretum			Queen Creek above Whitlow Ranch Dam		
Month	**Existing (cfs)**	**Proposed (cfs)**	**Decrease (%)**	**Existing (cfs)**	**Proposed (cfs)**	**Decrease (%)**	**Existing (cfs)**	**Proposed (cfs)**	**Decrease (%)**
January	5.63	4.61	−18.2	6.54	5.66	−13.4	23.90	23.02	−3.7
February	4.75	3.86	−18.6	5.50	4.75	−13.7	21.14	20.39	−3.6
March	2.61	2.12	−18.8	3.07	2.66	−13.5	12.11	11.69	−3.4
April	0.68	0.56	−17.8	0.81	0.71	−12.8	2.83	2.73	−3.7
May	0.20	0.16	−18.4	0.24	0.20	−13.4	0.87	0.84	−3.6
June	0.07	0.06	−18.5	0.08	0.07	−13.3	0.32	0.31	−3.5
July	0.31	0.25	−20.2	0.38	0.32	−14.3	1.50	1.44	−3.6
August	0.74	0.59	−19.6	0.98	0.84	−13.5	3.64	3.51	−3.6
September	0.64	0.51	−19.7	0.81	0.70	−13.6	3.27	3.16	−3.4
October	0.49	0.39	−19.5	0.63	0.54	−13.4	2.60	2.52	−3.2
November	0.83	0.67	−19.4	1.12	0.97	−13.0	5.07	4.93	−3.2
December	2.17	1.76	−18.6	2.68	2.33	−13.2	10.94	10.59	−2.9
Average	**1.58**	**1.28**	**−18.6**	**1.89**	**1.63**	**−13.4**	**7.28**	**7.03**	**−3.5**
Peak instantaneous streamflow (50% exceedance)	356	316	−11.2	–	–	–	–	–	–
30-day streamflow (50% exceedance)	4.4	3.9	−20.4	–	–	–	–	–	–

Sources: BGC Engineering (2018c); Lehman (2018)

Notes: Impacts shown are solely for effects from the subsidence area and West Plant Site. Combined impacts from the tailings storage facilities for Alternatives 2 and 3 (affecting Queen Creek above Whitlow Ranch Dam) and Alternative 4 (affecting Queen Creek at Boyce Thompson Arboretum and Queen Creek above Whitlow Ranch Dam) are detailed later in this section.

Numbers have been rounded for presentation.

cfs = cubic feet per second

alternatives, like the subsidence area and the West Plant Site. Additional losses occur under Alternatives 2, 3, and 4, shown later in this section.

IMPACTS ON SEDIMENT YIELDS AND GEOMORPHOLOGY OF STREAMS

Physical changes to watersheds can affect not just runoff, but also the sediment those flows carry downstream. One of the major functions of a stream is to transport sediment. All of the stream systems immediately downstream of project components are ephemeral in nature and only flow in response to precipitation. Ephemeral channels or washes have a cyclical pattern of infill and erosion. In this pattern, sediment movement usually occurs as pulses associated with flood events that push large amounts of coarse sediment through the system (Levick et al. 2008). The long-term stability of the downstream channel is based on the equilibrium between erosion and deposition of sediment delivered to the system. When that delivery system is disrupted or altered, changes to stream aggradation (the rising of the grade of a streambed) and scour (the erosive removal of sediment from a streambed) can occur until the system reaches equilibrium once again.

The beds of the downstream channels consist mostly of unsorted, unconsolidated sands, gravels, and cobbles. On smaller tributary washes higher in the watershed, particularly around the Near West (Alternatives 2 and 3) and Silver King (Alternative 4) sites, these sediments may be relatively shallow. Farther downstream, in Queen Creek (Alternatives 2, 3, and 4), Donnelly Wash (Alternative 5), or Dripping Spring Wash (Alternative 6), channels are often quite wide and sediments quite deep (Hart 2016).

All of these ephemeral washes are sediment transport–limited systems. This means that there is more sediment in the system than stormwater can transport. This is common in ephemeral streams due to the flashy (i.e., short duration) nature of flows. Flashy flows emanating from large precipitation events pick up sediment in a pulse of water and then deposit it quickly as flows recede.

Stormflows are expected to change both in the amount of flow and the magnitude of peak flows. For Queen Creek, a reduction in storm flow volume of roughly 19 percent is anticipated at Magma Avenue Bridge (all alternatives), dropping to 4 to 9 percent at Whitlow Ranch Dam (varies by alternative). These changes may result in both a reduced sediment supply to Queen Creek from impacted tributaries and less bedload transport in Queen Creek due to reduced tractive forces.

The potential reduction in sediment supply is not considered a significant impact because the system is sediment-transport limited. With respect to reduced sediment transport, such a reduction would be well within the natural variability of the system, as is evident from the historical data. The existing system already experiences significant variability in the potential for sediment transport for individual flood events. For example, the 2-year return period (50 percent annual probability) flood in Queen Creek for existing conditions is 1,280 cubic feet per second (cfs), compared with 15,830 cfs during a 100-year return period (1 percent annual probability) flood. That difference in peak flow is greater than an order of magnitude. Where the creek’s banks are composed of alluvium, an expected response to reduced peak flows might be a slight narrowing of the channel width proportional to the magnitude of the predicted flow reduction.

Additionally, these systems do not frequently flow. Therefore, any adjustments to the channel geometry would be very slow to occur and difficult to detect. There are two GDEs present along Queen Creek, between km 17.4 and 15.6, and at Whitlow Ranch Dam.[56] Both of these systems are adapted to heavy sediment loads occurring now in ephemeral systems and their function would not be impacted.

Impacts are slightly greater for Donnelly Wash (Alternative 5), with reduction in storm flow volume of roughly 21 percent at the confluence with the Gila River. Reductions in flows in Dripping Spring Wash

56. Kilometers are referenced here because many of the stream descriptions used by Resolution Copper reference the distance upstream of the confluence, measured in kilometers. For instance, spring “DC-8.4W” is located 8.4 km upstream of the mouth of Devil’s Canyon, on the west side of the drainage.

(Alternative 6) are roughly 13 percent at the confluence with the Gila River. These changes may result in both a reduced sediment supply to Donnelly Wash and Dripping Spring Wash from impacted tributaries and less bedload transport due to reduced tractive forces. As with Queen Creek, the potential reduction in sediment supply is not considered a significant impact for a sediment transport–limited system. No GDEs or aquatic habitat have been identified along either Donnelly Wash or Dripping Spring Wash. Tributaries upstream of the main stems of Queen Creek, Donnelly Wash, and Dripping Spring Wash exhibit greater changes; no aquatic habitat or GDEs exist in any of these tributaries.

IMPACTS ON WATER QUALITY FROM SEDIMENT CHANGES

Ground disturbance and removal of vegetation can increase sediment movement into downstream waters and affect water quality and aquatic habitat. Water quality is often characterized by the measurement of the amount of sediment per given amount of water (also known as the sediment concentration). As described in detail in section 3.7.2, during operations, stormwater controls would be in place for all major project components (West Plant Site, East Plant Site, tailings facilities, filter plant and loadout facility) to prevent stormwater that contacts tailings materials or processing areas from being discharged downstream. This prevents stormwater from moving downstream but also prevents any increases in sediment concentration from the disturbed areas. The remaining flows in the undisturbed part of the watershed would continue to move sediment at the concentrations found under normal conditions. The design storm event selected for sizing the stormwater management facilities at the East Plant Site, West Plant Site, and filter plant and loadout facility is the 100-year, 24-hour storm event, which Resolution Copper selected based on recommendations from the ADEQ Arizona Mining Guidance Manual BADCT (Arizona Department of Environmental Quality 2004; Resolution Copper 2016d). Note that tailings storage facilities themselves use much larger events in the design of their embankments, as discussed in section 3.10.1.

After closure and all reclamation has occurred, these stormwater controls would no longer be in place for most project components. Long-term revegetation is expected to be effective, and the reclaimed landforms stable without excessive erosion (see Section 3.3, Soils and Vegetation). Even with successful reclamation and revegetation, these areas would not return to pre-disturbance conditions; however, they would still meet a level of functioning condition as specified by the Forest Service. If desired long-term stability or revegetation conditions are not met, then financial assurance or bonds would not be released, and the Forest Service could maintain stormwater controls until revegetation is successful at stabilizing the disturbed ground surface. The long-term expectation is for most disturbed areas to return to the watershed in a condition without excess erosion or excess delivery of sediment.

Linear features, such as pipeline corridors, roads, and power line corridors, also result in ground disturbance but would not have operational stormwater controls in place to contain all runoff. Instead, stormwater permitting requirements under the AZPDES require that active stormwater controls remain in place until adequate site stabilization has occurred to minimize soil loss. Active stormwater controls typically are temporary measures that are designed and applied in a way specific to each location in order to prevent sediment movement into nearby water courses. Active controls require maintenance and eventually are removed once site stabilization has taken place. Active stormwater controls could include such items as silt fences, straw bales or rolls, dikes, sediment traps, or water bars; stabilization techniques could include such items as reseeding, soil treatment, or hardscaping. Provided adequate stormwater controls and best management practices are used, impacts from linear disturbance are generally minimal, since the amount of disturbance reporting to any one wash is relatively limited.

Stormwater and erosion controls applicable to each alternative are summarized in Newell and Garrett (2018d).

Alternative 2 – Near West Proposed Action

IMPACTS ON SURFACE RUNOFF AND STREAMFLOW

Changes in runoff from the subsidence area and West Plant Site would reduce average flows in Queen Creek at Whitlow Ranch Dam by about 4 percent; these losses in combination with additional changes caused by the tailings facility for Alternative 2 would reduce average flows by about 7 percent. As well as impacting flows in Queen Creek, Alternative 2 would impact flows in Roblas Canyon, Bear Tank Canyon, and Potts Canyon. Estimated changes in average monthly streamflow for these drainages are presented in table 3.7.3-6. All streamflow in Bear Tank Canyon would either be diverted into Potts Canyon or captured within the tailings storage facility footprint, resulting in a total loss of surficial runoff at the canyon's mouth. Surface runoff diverted into Potts Canyon results in a slight increase in streamflow for this watershed.

Table 3.7.3-6 also shows the peak instantaneous and 30-day (50 percent exceedance) streamflows for Queen Creek at Whitlow Ranch Dam. In percentages, changes in peak flows are similar to changes in average streamflow, with reductions from 3 to 7 percent.

IMPACTS ON JURISDICTIONAL WATERS OF THE U.S. (RELATED TO CLEAN WATER ACT SECTION 404 PERMIT)

Section 404 of the CWA requires issuance of a permit for discharge of dredged or fill material within jurisdictional waters of the U.S. Waters of the U.S. generally consist of aquatic features such as streams/washes and wetlands. The determination of what aquatic features are considered jurisdictional is made by the USACE.

In 2012 and 2015, the USACE issued determinations that no jurisdictional waters exist within substantial portions of the Queen Creek watershed upstream of Whitlow Ranch Dam, which includes the footprint of Alternative 2 (U.S. Army Corps of Engineers 2012a, 2015). Therefore, no jurisdictional waters would be impacted by Alternative 2.

IMPACTS ON FLOODPLAINS (RELATED TO EXECUTIVE ORDER 11988)

Mapped floodplains for Alternative 2 total 8.5 acres, where the eastern boundary of the West Plant Site overlaps the floodplain of a tributary to Queen Creek. Further information on floodplain acreages, including mapping coverage, is included in Newell and Garrett (2018d).

IMPACTS ON WETLANDS (RELATED TO EXECUTIVE ORDER 11990)

As previously noted, assessing wetlands under Executive Order 11990 is different from assessing jurisdictional waters under a CWA Section 404 permit. For the analysis in this section, the FWS National Wetlands Inventory is used to identify potential wetlands. Details of the wetlands identified from the National Wetlands Inventory are found in Newell and Garrett (2018d). Wetlands affected include

- xeroriparian vegetation along ephemeral washes (92.5 acres),
- stock tanks (5.1 acres for six separate tanks), and
- wetlands near Benson Spring and in the subsidence area (1 acre).

Alternative 3 – Near West – ultrathickened

Alternatives 2 and 3 have almost identical footprints; therefore, all streamflow impacts are the same as summarized in table 3.7.3-6. Impacts on potentially jurisdictional waters, floodplains, and wetlands would also be identical to Alternative 2.

Alternative 4 – Silver King

IMPACTS ON SURFACE RUNOFF AND STREAMFLOW

Changes in runoff from the subsidence area and West Plant Site would reduce average flows in Queen Creek at Whitlow Ranch Dam by about

Table 3.7.3-6. Estimated changes in average monthly streamflow and peak flood flows for Queen Creek and northern tributaries – Alternative 2

Month	Queen Creek above Whitlow Ranch Dam*			Roblas Canyon			Bear Tank Canyon			Potts Canyon		
	Existing (cfs)	Proposed (cfs)	Decrease (%)	Existing (cfs)	Proposed (cfs)	Decrease (%)	Existing (cfs)	Proposed (cfs)	Decrease (%)	Existing (cfs)	Proposed (cfs)	Increase (%)
January	23.90	22.29	−6.8	2.91	2.70	−7.1	1.20	0.0	−100	8.19	8.55	+4.5
February	21.14	19.80	−6.3	2.38	2.22	−6.7	0.96	0.0	−100	6.81	7.11	+4.4
March	12.11	11.33	−6.4	1.37	1.27	−7.6	0.54	0.0	−100	3.64	3.80	+4.6
April	2.83	2.64	−6.7	0.32	0.30	−7.9	0.13	0.0	−100	1.01	1.05	+3.9
May	0.87	0.81	−6.4	0.10	0.09	−7.4	0.04	0.0	−100	0.29	0.30	+4.2
June	0.32	0.30	−6.5	0.04	0.03	−7.5	0.01	0.0	−100	0.10	0.11	+4.3
July	1.50	1.39	−7.3	0.19	0.17	−9.5	0.08	0.0	−100	0.45	0.48	+4.7
August	3.64	3.40	−6.7	0.40	0.37	−7.7	0.17	0.0	−100	1.19	1.24	+4.5
September	3.27	3.05	−6.5	0.38	0.35	−8.3	0.15	0.0	−100	1.04	1.09	+4.3
October	2.60	2.43	−6.4	0.29	0.26	−8.5	0.12	0.0	−100	0.78	0.81	+4.4
November	5.07	4.76	−6.2	0.58	0.53	−8.7	0.25	0.0	−100	1.41	1.47	+4.7
December	10.94	10.23	−6.5	1.25	1.14	−8.7	0.52	0.0	−100	3.34	3.48	+4.3
Average	**7.28**	**6.81**	**−6.5**	**0.84**	**0.78**	**−7.5**	**0.35**	**0.0**	**−100**	**2.33**	**2.44**	**+4.4**
Peak instantaneous streamflow (50 % exceedance)	1,280	1,238	−3.3	–	–	–	–	–	–	–	–	–
30-day streamflow (50 % exceedance)	34.8	32.4	−6.9	–	–	–	–	–	–	–	–	–

Sources: BGC Engineering (2018c); Lehman (2018)

Note: Numbers have been rounded for presentation.

* Calculations reflect the combined effects of subsidence, West Plant Site, and Alternative 2 tailings storage facility.

4 percent; these losses, combined with additional changes caused by the tailings facility for Alternative 4, would reduce average flows by about 9 percent. Alternative 4 also impacts flows at Boyce Thompson Arboretum, reducing average flows by about 20 percent. Additional flow losses would also occur under Alternative 4, with the proposed tailings storage facility impacting flows in Happy Canyon, Silver King Wash, and Potts Canyon. Estimated changes in average monthly streamflow are presented in table 3.7.3-7 (Queen Creek) and table 3.7.3-8 (northern tributaries). Whereas the tailings storage facility disturbance footprint within Silver King Wash is 0.21 square mile, portions of the Potts Canyon and Happy Canyon watersheds are diverted into Silver King Wash. As a result, the overall impact on streamflow in this wash is only 0.5 percent on average.

Table 3.7.3-7 also shows the peak instantaneous and 30-day (50 percent exceedance) streamflows for Queen Creek at Whitlow Ranch Dam. In percentages, changes in peak flows are similar to changes in average streamflow, with reductions from 3 to 7 percent.

IMPACTS ON JURISDICTIONAL WATERS OF THE U.S. (RELATED TO CLEAN WATER ACT SECTION 404 PERMIT)

As with Alternatives 2 and 3, the USACE issued determinations that no jurisdictional waters exist within substantial portions of the Queen Creek watershed upstream of Whitlow Ranch Dam, which includes the footprints of these alternatives. Therefore, no jurisdictional waters would be impacted by Alternative 4.

IMPACTS ON FLOODPLAINS (RELATED TO EXECUTIVE ORDER 11988)

Floodplain impacts for Alternative 4 are identical to those for Alternatives 2 and 3. Further information on floodplain acreages, including mapping coverage, is included in Newell and Garrett (2018d).

IMPACTS ON WETLANDS (RELATED TO EXECUTIVE ORDER 11990)

As previously noted, assessing wetlands under Executive Order 11990 is different from assessing jurisdictional waters under a CWA Section 404 permit. For the analysis in this section, the FWS National Wetlands Inventory is used to identify potential wetlands. Details of the wetlands identified from the National Wetlands Inventory are found in Newell and Garrett (2018d). Wetlands affected include

- xeroriparian vegetation along ephemeral washes (86.2 acres),
- stock tanks (4.1 acres for five separate tanks), and
- a wetland in the subsidence area (0.2 acre).

Alternative 5 – Peg Leg

IMPACTS ON SURFACE RUNOFF AND STREAMFLOW

Streamflow at the mouth of Donnelly Wash and a smaller tributary to the immediate north (herein called “unnamed wash”) would be impacted by the Alternative 5 tailings storage facility footprint. Estimated changes in average monthly streamflow are presented in table 3.7.3-9.

Average monthly streamflows for the Gila River are based on USGS gage 09474000, “Gila River at Kelvin, AZ.” Streamflow records for this gage extend as far back as 1911. Monthly values reported in table 3.7.3-9 are averages for the 1981–2016 period. This USGS gage is located approximately 15 miles upstream of the Donnelly Wash confluence.

This table also shows the peak instantaneous and 30-day (50 percent exceedance) streamflows for Donnelly Wash. Potential changes in streamflow discharge-duration-frequency for the Gila River have not been estimated for two reasons:

Table 3.7.3-7. Estimated changes in average monthly streamflow and peak flood flows for Queen Creek – Alternative 4

	Queen Creek at Boyce Thompson Arboretum			Queen Creek above Whitlow Ranch Dam		
Month	**Existing (cfs)**	**Proposed (cfs)**	**Decrease (%)**	**Existing (cfs)**	**Proposed (cfs)**	**Decrease (%)**
January	6.54	5.24	−19.8	23.90	21.66	−9.4
February	5.50	4.40	−20.0	21.14	19.25	−8.9
March	3.07	2.46	−19.9	12.11	11.08	−8.5
April	0.81	0.66	−18.8	2.83	2.57	−9.3
May	0.24	0.19	−19.7	0.87	0.79	−9.1
June	0.08	0.07	−19.6	0.32	0.29	−8.9
July	0.38	0.30	−21.3	1.50	1.36	−9.0
August	0.98	0.77	−20.7	3.64	3.29	−9.6
September	0.81	0.64	−20.4	3.27	2.98	−8.8
October	0.63	0.50	−20.2	2.60	2.38	−8.4
November	1.12	0.89	−20.3	5.07	4.68	−7.9
December	2.68	2.15	−19.7	10.94	10.03	−8.4
Average	**1.89**	**1.51**	**−19.9**	**7.28**	**6.64**	**−8.9**
Peak instantaneous streamflow (50% exceedance)	–	–	–	1,280	1,239	−3.2
30-day streamflow (50% exceedance)	–	–	–	34.8	32.4	−6.9

Sources: BGC Engineering (2018c); Lehman (2018)
Notes: Numbers have been rounded for presentation. Calculations reflect the combined effects of subsidence, West Plant Site, and Alternative 4 tailings storage facility.

Table 3.7.3-8. Estimated changes in average monthly streamflow and peak flood flows for Queen Creek tributaries – Alternative 4

	Silver King Wash			Happy Canyon			Potts Canyon		
Month	Existing (cfs)	Proposed (cfs)	Change (%)	Existing (cfs)	Proposed (cfs)	Decrease (%)	Existing (cfs)	Proposed (cfs)	Decrease (%)
January	3.23	3.23	−0.2	0.99	0.44	−55.3	8.19	6.49	−20.7
February	2.68	2.66	−0.6	0.84	0.38	−54.1	6.81	5.39	−20.7
March	1.48	1.48	−0.3	0.52	0.26	−50.6	3.64	2.88	−20.8
April	0.41	0.41	0.7	0.11	0.05	−58.0	1.01	0.82	−19.4
May	0.12	0.12	0.0	0.03	0.01	−57.1	0.29	0.23	−20.3
June	0.04	0.04	−0.1	0.01	0.01	−53.8	0.10	0.08	−20.4
July	0.19	0.19	−0.8	0.07	0.03	−51.5	0.45	0.36	−21.8
August	0.47	0.47	−1.4	0.18	0.09	−49.9	1.19	0.92	−22.6
September	0.41	0.41	−0.5	0.14	0.07	−51.4	1.04	0.83	−21.0
October	0.31	0.31	−0.9	0.11	0.05	−50.1	0.78	0.61	−21.4
November	0.53	0.53	−1.6	0.23	0.13	−45.1	1.41	1.10	−21.9
December	1.31	1.30	−0.7	0.46	0.23	−49.7	3.34	2.64	−20.8
Average	**0.93**	**0.92**	**−0.5**	**0.31**	**0.15**	**−52.5**	**2.33**	**1.85**	**−20.9**

Source: BGC Engineering (2018c)

Note: Numbers have been rounded for presentation.

Table 3.7.3-9. Estimated changes in average monthly streamflow and peak flood flows for Donnelly Wash, Unnamed Wash, and Gila River – Alternative 5

	Donnelly Wash at Mouth			Unnamed Wash at Mouth			Gila River at Donnelly Wash		
Month	**Existing (cfs)**	**Proposed (cfs)**	**Decrease (%)**	**Existing (cfs)**	**Proposed (cfs)**	**Decrease (%)**	**Existing (cfs)**	**Proposed (cfs)**	**Decrease (%)**
January	13.19	10.23	−22.5	1.18	0.87	−26.1	746	743.2	−0.4
February	9.26	7.14	−22.9	0.82	0.60	−26.7	554	551.3	−0.4
March	5.27	4.09	−22.3	0.55	0.43	−22.0	852	850.3	−0.2
April	1.31	1.03	−21.0	0.13	0.10	−22.5	609	608.4	0.0
May	0.34	0.25	−24.8	0.03	0.02	−26.3	536	536.1	0.0
June	0.14	0.11	−22.7	0.01	0.01	−24.1	636	636.3	0.0
July	0.66	0.55	−15.8	0.05	0.04	−21.9	744	743.9	0.0
August	2.32	1.92	−17.2	0.19	0.14	−22.3	720	719.1	−0.1
September	1.49	1.21	−19.3	0.16	0.13	−18.9	345	344.5	−0.1
October	2.10	1.66	−20.9	0.22	0.18	−20.5	252	251.2	−0.2
November	3.13	2.53	−19.3	0.27	0.21	−23.0	61	60.5	−1.1
December	5.30	4.29	−19.1	0.54	0.43	−19.6	245	243.4	−0.5
Average	**3.69**	**2.90**	**−21.3**	**0.34**	**0.26**	**−23.7**	**526**	**525.0**	**−0.2**
Peak instantaneous streamflow (50 % exceedance)	866	784	−9.5	–	–	–	–	–	–
30-day streamflow (50 % exceedance)	10.9	8.9	−18.4	–	–	–	–	–	–

Sources: BGC Engineering (2018c); Lehman (2018)

Notes: Numbers have been rounded for presentation.

Some uncertainty has been noted for the monthly water balance model as used on Donnelly Wash, due to the difference in watershed characteristics, compared with Pinto Creek, which was used to calibrate the model.

- The upstream Coolidge/San Carlos Reservoir regulates flow, making it difficult to conduct a flood frequency analysis (Lehman 2018); and
- The total drainage area reductions are very small (<0.1 percent) for the Peg Leg alternative.

IMPACTS ON JURISDICTIONAL WATERS OF THE U.S. (RELATED TO CLEAN WATER ACT SECTION 404 PERMIT)

Unlike locations within the Queen Creek watershed, the USACE has not made any determination on potentially jurisdictional waters for the Peg Leg location. However, based on discussions between the USACE and the Forest Service, it is believed that washes within the Donnelly Wash watershed would be considered jurisdictional waters of the U.S. and would be subject to permitting under Section 404 of the CWA.

It is estimated that approximately 759,064 linear feet of potentially jurisdictional waters are located within the footprint of the Alternative 5 tailings storage facility, potentially impacting 182.5 acres of waters of the U.S. (WestLand Resources Inc. 2018c). No potentially jurisdictional wetlands were noted within the footprint of Alternative 5 during field surveys. The USACE also considers indirect impacts from the "dewatering" of downgradient reaches through upgradient fills; these have not been estimated. Indirect impacts are generally considered to extend from the point of fill down to the confluence with the next substantial drainage.

IMPACTS ON FLOODPLAINS (RELATED TO EXECUTIVE ORDER 11988)

Impacts on floodplains for Alternative 5 differ slightly by pipeline route, with impacts of 171 acres for the eastern pipeline corridor and tailings storage facility footprint, and 167 acres for the western pipeline corridor and tailings storage facility footprint. This includes 8.5 acres for the West Plant Site, identical to Alternatives 2, 3, and 4.

Floodplains are associated with Donnelly Wash and an unnamed tributary wash. The eastern pipeline corridor alternative crosses mapped floodplains associated with the Gila River and Walnut Canyon. The western pipeline corridor alternative crosses mapped floodplains associated with the Gila River and Cottonwood Creek.

IMPACTS ON WETLANDS (RELATED TO EXECUTIVE ORDER 11990)

As previously noted, assessing wetlands under Executive Order 11990 is different from assessing jurisdictional waters under a CWA Section 404 permit. For the analysis in this section, the FWS National Wetlands Inventory is used to identify potential wetlands. Details of the wetlands identified from the National Wetlands Inventory are found in Newell and Garrett (2018d).

Wetland impacts for the eastern pipeline corridor alternative include

- xeroriparian vegetation along ephemeral washes (200.9 acres),
- the Gila River and Queen Creek crossings,
- stock tanks (8.6 acres for six separate tanks), and
- a wetland in the subsidence area (0.2 acre).

Wetland impacts for the western pipeline corridor alternative include

- xeroriparian vegetation along ephemeral washes (219.6 acres),
- the Gila River crossing,
- stock tanks (8.8 acres for five separate tanks), and
- a wetland in the subsidence area (0.2 acre).

Table 3.7.3-10. Estimated changes in average monthly streamflow and peak flood flows for Dripping Spring Wash and Gila River – Alternative 6

	Dripping Spring Wash at Mouth			Gila River at Dripping Spring Wash Confluence			Gila River at Donnelly Wash Confluence		
Month	**Existing (cfs)**	**Proposed (cfs)**	**Decrease (%)**	**Existing (cfs)**	**Proposed (cfs)**	**Decrease (%)**	**Existing (cfs)**	**Proposed (cfs)**	**Decrease (%)**
January	43.66	35.06	−12.8	436	427.9	−2.0	746	740.9	−0.7
February	31.65	25.08	−13.5	384	377.5	−1.7	554	549.4	−0.8
March	16.89	13.34	−13.6	701	697.7	−0.5	852	849.3	−0.3
April	4.12	3.27	−13.4	562	561.1	−0.2	809	608.1	−0.1
May	1.11	0.87	−13.9	536	535.8	0.0	536	536.0	0.0
June	0.46	0.36	−13.5	642	642.0	0.0	636	636.3	0.0
July	1.44	1.16	−12.4	687	686.4	0.0	744	743.8	0.0
August	3.84	3.10	−12.5	602	601.3	−0.1	720	719.1	−0.1
September	3.27	2.63	−12.6	288	287.7	−0.2	345	344.4	−0.1
October	4.63	3.87	−10.6	153	152.7	−0.5	252	251.2	−0.2
November	7.92	6.44	−12.1	33	32.0	−4.4	61	60.2	−1.6
December	16.17	12.96	−12.9	179	175.5	−1.8	245	242.5	−0.9
Average	**11.18**	**8.94**	**−12.9**	**435**	**432.5**	**−0.5**	**526**	**524.4**	**−0.3**
Peak instantaneous streamflow (50% exceedance)	1,168	1,114	−4.7	–	–	–	–	–	–
30-day streamflow (50% exceedance)	36.2	32.7	−9.7	–	–	–	–	–	–

Sources: BGC Engineering (2018c); Lehman (2018)

Note: Numbers have been rounded for presentation.

Alternative 6 – Skunk Camp

IMPACTS ON SURFACE RUNOFF AND STREAMFLOW

Streamflow at the mouth of Dripping Spring Wash would be impacted both by the Alternative 6 tailings storage facility footprint and the northern diversion channels, which divert water into the Mineral Creek watershed. Estimated changes in average monthly streamflow are presented in table 3.7.3-10.

Average monthly streamflows for the Gila River are based on USGS gage 09469500, “Gila River below Coolidge Dam, AZ.” Streamflow records for this gage extend as far back as 1899. Monthly values reported in table 3.7.3-10 are averages for the 1981–2016 period. This USGS gage is located approximately 20 miles upstream of the Dripping Spring Wash confluence.

Table 3.7.3-10 also shows the peak instantaneous and 30-day (50 percent exceedance) streamflows for Donnelly Wash. As with Alternative 5, potential changes in streamflow discharge-duration-frequency for the Gila River were not estimated.

IMPACTS ON JURISDICTIONAL WATERS OF THE U.S. (RELATED TO CLEAN WATER ACT SECTION 404 PERMIT)

Similar to the Peg Leg location, the USACE has not made any determination on potentially jurisdictional waters for the Skunk Camp location. However, based on discussions between the USACE and the Forest Service, it is believed that washes within the Dripping Spring watershed would be considered jurisdictional waters of the U.S. and would be subject to permitting under Section 404 of the CWA.

It is estimated that approximately 395,215 linear feet of potentially jurisdictional waters are located within the footprint of the Alternative 6 tailings storage facility, potentially impacting 120.0 acres of waters of the U.S. (WestLand Resources Inc. 2018c). No potentially jurisdictional wetlands were noted within the footprint of Alternative 6 during field surveys. The USACE also considers indirect impacts from the “dewatering” of downgradient reaches through upgradient fills; these have not been estimated. Indirect impacts are generally considered to extend from the point of fill down to the confluence with the next substantial drainage.

IMPACTS ON FLOODPLAINS (RELATED TO EXECUTIVE ORDER 11988)

Impacts on floodplains for Alternative 6 total 794 acres. This includes 8.5 acres for the West Plant Site, identical to Alternatives 2, 3, and 4.

Floodplains associated with Dripping Spring Wash and tributaries include Stone Cabin Wash and Skunk Camp Wash. Both pipeline corridor alternatives cross Devil’s Canyon and Mineral Creek but do not impact mapped floodplains. The southern pipeline corridor alternative also crosses Queen Creek west of Superior; floodplains have not been mapped in this area but are likely to exist. The northern pipeline corridor alternative crosses Queen Creek east of Superior; floodplains are not mapped but are unlikely to exist in this area based on existing mapped segments.

IMPACTS ON WETLANDS (RELATED TO EXECUTIVE ORDER 11990)

As previously noted, assessing wetlands under Executive Order 11990 is different from assessing jurisdictional waters under a CWA Section 404 permit. For the analysis in this section, the FWS National Wetlands Inventory is used to identify potential wetlands. Details of the wetlands identified from the National Wetlands Inventory are found in Newell and Garrett (2018d).

Wetland impacts for the southern pipeline corridor alternative include

- xeroriparian vegetation along ephemeral washes (232.9 acres),
- wetlands associated with Queen Creek, Devil’s Canyon, and Mineral Creek (28.2 acres),
- stock tanks (11.9 acres for 15 separate tanks), and

- a wetland in the subsidence area (0.2 acre).

Wetland impacts for the northern pipeline corridor alternative include

- xeroriparian vegetation along ephemeral washes (229.6 acres),
- wetlands associated with Mineral Creek (25.4 acres),
- stock tanks (12.7 acres for 17 separate tanks), and
- a wetland in the subsidence area (0.2 acre).

Cumulative Effects

The Tonto National Forest identified the following reasonably foreseeable future actions as likely, in conjunction with development of the Resolution Copper Mine, to contribute to cumulative impacts on surface water quantity. As noted in section 3.1, past and present actions are assessed as part of the affected environment; this section analyzes the effects of any RFFAs, to be considered cumulatively along with the affected environment and Resolution Copper Project effects.

- *Pinto Valley Mine Expansion.* The Pinto Valley Mine is an existing open-pit copper and molybdenum mine located approximately 8 miles west of Miami, Arizona, in Gila County. Pinto Valley Mining Corporation is proposing to expand mining activities onto an estimated 1,011 acres of new disturbance (245 acres on Tonto National Forest land and 766 acres on private land owned by Pinto Valley Mining Corporation) and extend the life of the mine to 2039. While impacts are foreseen with Pinto Creek, these actions are in an entirely different watershed than could be affected by Resolution Copper Mine–related activities (Pinto Creek ultimately flows to Roosevelt Lake), and there are unlikely to be cumulative effects with the Resolution Copper Project.
- *Ripsey Wash Tailings Project.* Mining company ASARCO is planning to construct a new tailings storage facility to support its Ray Mine operations. The environmental effects of the project were analyzed in an EIS conducted by the USACE and approved in a ROD issued in December 2018. As approved, the proposed tailings storage facility project would occupy an estimated 2,574 acres and be situated in the Ripsey Wash watershed just south of the Gila River approximately 5 miles west-northwest of Kearny, Arizona, and would contain up to approximately 750 million tons of material (tailings and embankment material). ASARCO estimates a construction period of 3 years and approximately 50 years of expansion of the footprint of the tailings storage facility as slurry tailings are added to the facility, followed by a 7- to 10-year period for reclamation and final closure. This project is estimated to result in a reduction of recharge to the Gila River of 0.2 percent. This would be cumulative with losses from either Alternative 5 (estimated reduction in flow in the Gila River at Donnelly Wash of 0.2 percent) or Alternative 6 (estimated reduction in flow in the Gila River at Donnelly Wash of 0.3 percent).
- *Silver Bar Mining Regional Landfill and Cottonwood Canyon Road.* AK Mineral Mountain, LLC, NL Mineral Mountain, LLC, POG Mineral Mountain, LLC, SMT Mineral Mountain, LLC, and Welch Mineral Mountain, LLC are proposing to build a municipal solid waste landfill on private property surrounded by BLM land (Middle Gila Canyons area). Site access would require crossing BLM land. An unnamed ephemeral wash passing through the landfill site would be impacted by the landfill's construction. No proposed landfill may be located within 0.5 mile of a 100-year floodplain with flows in excess of 25,000 cfs; however, the hydrologic analysis generated a 100-year peak flow on Cottonwood Canyon Wash of less than 3,800 cfs. Cottonwood Canyon is tributary to Queen Creek, but much of the flow is lost to overland flow as it exits the mountains east of the Salt River valley, and there are unlikely to be cumulative effects with Resolution Copper Project–related impacts.
- *Ray Land Exchange and Proposed Plan Amendment.* ASARCO is also seeking to complete a land exchange with the BLM by which the mining company would gain title to approximately

10,976 acres of public lands and federally owned mineral estate located near ASARCO's Ray Mine in exchange for transferring to the BLM approximately 7,304 acres of private lands, primarily in northwestern Arizona. It is known that at some point ASARCO wishes to develop a copper mining operation in the "Copper Butte" area west of the Ray Mine; however, no details are currently available as to potential environmental effects, including to surface waters, resulting from this possible future mining operation. Given the location of this activity, impacts on water could potentially be cumulative with Resolution Copper Project–related impacts on the Gila River for Alternatives 5 and 6.

- *LEN Range Improvements.* This range allotment is located near Ray Mine. Under the proposed action, upland perennial sources of water would be provided to supplement the existing upland water infrastructure on the allotment. The supplemental water sources would provide adequate water facilities for existing authorized grazing management activities. While beneficial, these water sources are located in a different geographic area than the GDEs potentially impacted by the Resolution Copper Project.
- *Millsite Range Improvements.* This range allotment is located 20 miles east of Apache Junction, on the southern end of the Mesa Ranger District. The Mesa Ranger District is proposing to add three new 10,000-gallon storage tanks and two 600-gallon troughs to improve range condition through better livestock distribution and to provide additional wildlife waters in three pastures on the allotment. Water developments are proposed within the Cottonwood, Bear Tanks, and Hewitt pastures of the Millsite grazing allotment. These improvements would be beneficial for providing water on the landscape and are within the same geographic area where some water sources could be lost (Alternatives 2 and 3); they may offset some loss of water that would result because of the Resolution Copper Project–related tailings storage facility construction.

Other projects and plans are certain to occur or to be in place during the foreseeable life of the Resolution Copper Mine (50–55 years). These, combined with general population increase and ground-disturbing activities, may cumulatively contribute to future changes to surface water quantity.

Mitigation Effectiveness

The Forest Service is in the process of developing a robust mitigation plan to avoid, minimize, rectify, reduce, or compensate for resource impacts that have been identified during the process of preparing this EIS. Appendix J contains descriptions of mitigation concepts being considered and known to be effective, as of publication of the DEIS. Appendix J also contains descriptions of monitoring that would be needed to identify potential impacts and mitigation effectiveness. As noted in chapter 2 (section 2.3), the full suite of mitigation would be contained in the FEIS, required by the ROD, and ultimately included in the final GPO approved by the Forest Service. Public comment on the EIS, and in particular appendix J, will inform the final suite of mitigations.

This section contains an assessment of the effectiveness of mitigation and monitoring measures found in appendix J that are applicable to surface water quantity.

MITIGATION MEASURES APPLICABLE TO SURFACE WATER QUANTITY

Compensatory mitigation plan (RC-217): One mitigation measure is contained in appendix J that would be applicable to surface water quantity and is contained in full in appendix D. In May 2019, the Forest Service received from Resolution Copper a document titled "Draft Resolution Copper Project, Clean Water Act Section 404, Conceptual Mitigation Plan" (WestLand Resources Inc. 2019). This document outlines the concepts being proposed to the USACE for compensatory mitigation required under Section 404 of the CWA.

The document includes a detailed functional assessment of the types of ephemeral washes and xeroriparian habitat found at the Alternative 6 location, and then identifies six off-site mitigation opportunities to address these losses. No on-site mitigation opportunities were identified.

The six off-site opportunities are as follows:

- *The Gila River Indian Community MAR-5 Recharge Project.* This project involved a 3-year pilot study to discharge water back into the Gila River on the Gila River Indian Community. The pilot project resulted in a five-fold increase in total vegetation volume and a six-fold increase in total herbaceous cover, and at the end of the pilot study the site was populated with desirable riparian species including cattails and willow. Tamarisk density at the site also increased substantially and any ecological lift may be negatively impacted by the presence and density of tamarisk. The project would involve enhancement and continuation of the project.
- *The Lower San Pedro River Wildlife Area In-lieu Fee Project.* In-lieu fee programs allow impacts on surface water features to be mitigated through funds paid to a governmental or non-profit natural resources management entity. The Lower San Pedro River Wildlife Area in-lieu fee project consists of converting over 100 acres of agricultural fields to native pasture grasses to reduce groundwater consumption and help restore base flows and riparian habitat. Additionally, the restoration project will involve substantial exotic species removal and subsequent plantings to establish native woody vegetation within the 2,116-acre site.
- *The Olberg Road Restoration Site Project.* This is a proposed 23-acre restoration site located along the south bank of the Gila River just east of the Olberg Bridge, immediately upstream of the MAR-5 site. Restoration would consist of exotic tree species (principally tamarisk) removal and control, combined with native plant species reseeding.
- *The Queen Creek Project.* This project consists of actions to improve the ecological condition of a stretch of Queen Creek near Superior, Arizona, including the removal of tamarisk to allow riparian vegetation to return to its historic composition and structure and promote more natural stream functions. Additionally, a conservation easement would be established, covering approximately 150 acres along 1.8 miles of Queen Creek to restrict future development of the site and provide protected riparian and wildlife habitat.
- *The Arlington Wildlife Area In-lieu Fee Project.* This is a 1,500-acre wetland and riparian habitat restoration project along the west bank of the Gila River in Maricopa County, southwest of the Phoenix metropolitan area.
- *The Lower San Pedro River BHP Parcel Preservation Project.* This would involve the preservation through a conservation easement (or similar instrument) of land parcels currently owned and managed by BHP that encompass the San Pedro River riparian corridor and adjacent bosque habitat along an approximately 5-mile stretch of the San Pedro River east of San Manuel, Arizona.

MITIGATION EFFECTIVENESS AND IMPACTS

Effectiveness of Mitigation

The exact type and amount of mitigation is not yet quantified, but all of the conceptual mitigations would be effective at enhancing, increasing, or improving the overall riparian habitat within the state of Arizona. How pertinent these improvements would be to the impacts from the Resolution Copper Project is primarily a reflection of their location.

The Queen Creek Project is on the same stream that would be impacted by reduced surface flows, as well as groundwater drawdown. Mitigation at this location would represent a direct offset of any lost riparian function.

The MAR-5 and Olberg Road projects are both on the Gila River, but no loss in riparian function is anticipated on the Gila River, as the reductions in average flow are relatively small (0.3 to 0.5 percent). In addition, the Gila River flow is largely diverted upstream of Florence and any impacts would be unlikely to be noticed on the Gila River Indian Community at the locations of these mitigation projects. These projects would not reflect a direct offset of impacts but would still reflect a replacement of riparian function on the same stream system.

The two Lower San Pedro projects and the Arlington Wildlife Area project both would help replace riparian function, but in different watersheds. Conceptually, the Lower San Pedro projects are upstream of any impacts that would be seen on the Gila River and potentially could be considered direct offsets, although there is a substantial distance between these locations and the Gila River. The Arlington Wildlife Area project is on the Gila River but far downstream and removed from the potential impacts. These projects most likely would not reflect a direct offset of impacts but would still reflect a replacement of riparian function in the greater Gila River watershed.

Impacts from Mitigation Actions

The exact type and amount of improvement is not yet quantified, nor are any additional ground disturbance or physical effects that would result from these actions.

UNAVOIDABLE ADVERSE IMPACTS

The primary impact described in the analysis (in this section, as well as section 3.7.1) is the loss of surface water flow to riparian areas (including xeroriparian vegetation along ephemeral washes) and loss of surface flow to any GDEs that are associated with these drainages. With the possible exception of the Queen Creek project, the conceptual mitigation proposed under the CWA would not be effective at avoiding, minimizing, rectifying, or reducing these impacts. Rather, the proposed conceptual mitigation would be mostly effective at offsetting impacts caused by reduced surface water flows by replacing riparian function far upstream or downstream of project impacts.

As the subsidence area is unavoidable, the loss of runoff to the watershed due to the subsidence area is also unavoidable, as are any effects on GDEs from reduced annual flows. The loss of water to the watershed due to the tailings facility (during operations, prior to successful reclamation) is unavoidable as well, due to water management and water quality requirements. Direct impacts on wetlands, stock tanks, and ephemeral drainages from surface disturbance are also unavoidable.

Other Required Disclosures

SHORT-TERM USES AND LONG-TERM PRODUCTIVITY

Desert washes, stock tanks, and wetland areas in the footprint of the subsidence area and tailings storage facility would be permanently impacted. In the short term, over the operational life of the mine, precipitation would be lost to the watershed. In the long term, most precipitation falling at the tailings facility would return to the watershed after closure and successful reclamation. There would be a permanent reduction in the quantity of surface water entering drainages as a result of capture of runoff by the subsidence area.

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

With respect to surface water flows from the project area, all action alternatives would result in both irreversible and irretrievable commitment of surface water resources. Irreversible commitment of surface water flows would result from the permanent reduction in stormwater flows into downstream drainages from the subsidence area. Changes to wetlands, stock tanks, and ephemeral drainages caused by surface disturbance would also be irreversible. Irretrievable commitment of surface water resources would be associated with additional temporary diversion, storage, and use of stormwater during active mining, but that would be restored to the watershed after closure and reclamation.

Overview

Many species—including birds, amphibians, fish, and mammals—rely in some way on the habitat that could be impacted by the proposed action or alternatives. This habitat is important for forage, mating, protective cover, nesting and denning, and travel. Some species in the area have special protection, such as under the Endangered Species Act or the Migratory Bird Treaty Act, and other species have been given special status by the Forest Service. Wildlife impacts can occur not just from habitat loss and fragmentation, but also from artificial lighting, noise, vibration, traffic, loss of water sources, or changes in air or water quality or quantity.

3.8 Wildlife and Special Status Wildlife Species

3.8.1 Introduction

This section documents and analyzes the occurrence and distribution of wildlife species within the analysis area, including wildlife movement corridors, general wildlife, and special status wildlife species. Special status wildlife species are those listed under the ESA, and Tonto National Forest Sensitive species, as well as BLM Sensitive species, migratory birds, other species that are afforded protection within the analysis area, and species that AGFD focuses on for conservation efforts. A description of vegetation communities that serve as habitat are included in Section 3.3, Soils and Vegetation.

This section includes descriptions of the affected environment, including the occurrence and distribution of general wildlife and game species, descriptions of special habitat areas (such as important bird areas, caves, and springs), wildlife connectivity across the larger landscape, special status wildlife species, and management indicator species (which are a specific Forest Service concern). Impacts analyzed include general impacts on wildlife occurring from construction, operation, and reclamation and closure, additional impacts that are specific to wildlife groups (mammals, birds, reptiles, amphibians, and invertebrates), and impacts on special status wildlife species. Some aspects of the analysis are briefly summarized in this section. Additional details not included are captured in the project record (Newell 2018j).

3.8.2 Analysis Methodology, Assumptions, and Uncertain and Unknown Information

3.8.2.1 Analysis Area

The analysis area covers the project footprint plus a 1-mile buffer, as well as areas along Queen Creek and Devil's Canyon where groundwater drawdown or reductions in surface water could change habitat (figure 3.8.2-1). Much of the impact on species and habitat is caused by direct disturbance of the land and vegetation. The 1-mile buffer and areas of Queen Creek and Devil's Canyon was determined by using the areas where the noise analyses, water analyses (i.e., groundwater and surface water quantity/quality analyses), fugitive dust distance affecting air quality, and noxious weed introduction and spread (Foxcroft et al. 2007) indicate the potential for impacts.

According to the air quality analysis, ambient air quality standards would be achieved at the project footprint boundaries; therefore, any potential air quality impacts are encompassed within the 1-mile buffer. The noise modeling shows that for all action alternatives, noise levels at 1 mile would be at or below the level of normal human conversation; as such, the 1-mile buffer is sufficient to address potential impacts from noise-producing activities. We also expect light associated with project construction and facilities to increase night-sky brightness from 1 to 9 percent (Dark Sky Partners LLC 2018). Light impacts would occur across the landscape but available research suggests any substantial impacts would occur within the

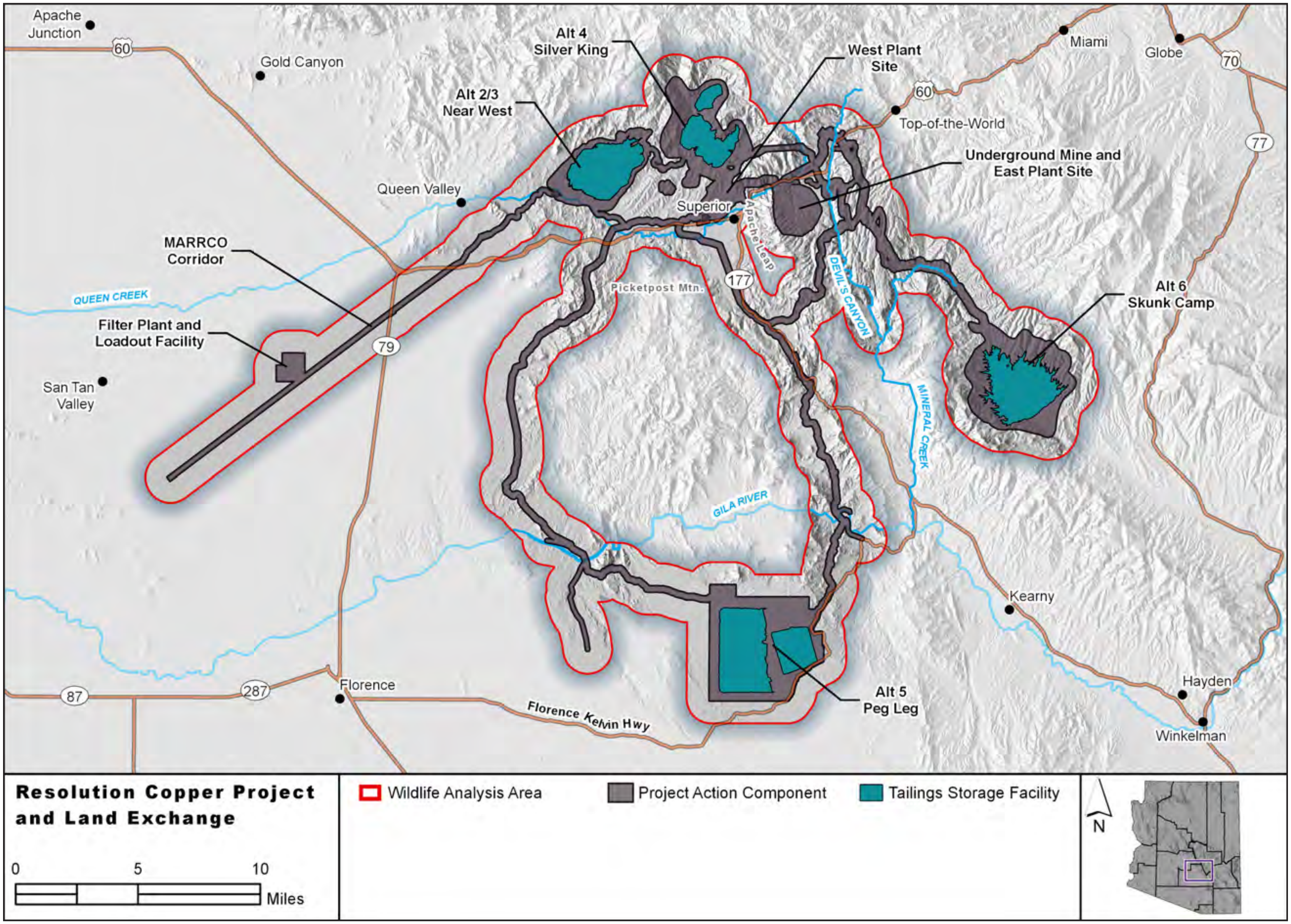


Figure 3.8.2-1. Wildlife analysis area

1-mile buffer (Newell 2018j). Species' movement corridors include areas outside the 1-mile buffer; we address potential impacts on those corridors at a landscape level.

AGFD is a cooperating agency and made species records and other information available to the Forest Service for use in the analysis. AGFD searched for records within the project footprint plus a 5-mile buffer; this information was used to determine the likelihood of occurrence of each species. This search area is greater than the analysis area and thus errs on the side of including more species records rather than less. Although the analysis area is a 1-mile buffer, data provided by the AGFD was within a 5-mile buffer and could not be clipped to the 1-mile buffer. This larger 5-mile buffer is clearly noted when it has been used.

The temporal parameters for this analysis involved the time frames for (1) construction: mine years 1 through 9, (2) operation: mine years 6 through 46, and (3) post-closure/reclamation: mine years 46 through 51 to 56, plus any additional years that are identified in other resource analysis (e.g., the groundwater analysis used to inform this section predicts out to 200 years). Construction activities would overlap operations activities for approximately 6 years.

3.8.2.2 Analysis Methodology

The goal of this analysis is to identify the potential impacts on wildlife and special status wildlife species and their habitats, from all activities associated with each project alternative. Several elements constitute the core of this analysis: (1) the factors for analysis identified during the NEPA scoping process, (2) survey and records data provided as part of this project, and (3) a scientific examination using current literature on species and how environmental changes (human or natural) affect species and their habitat.

Additional information and details, including analysis methods, species accounts, occurrence records, etc., on wildlife resources discussed in this section can be found in the background documentation (see appendix A in Newell (2018j)). The uncertainties and unknown information, as well as assumptions, of this analysis include (1) limitations in the use of GIS data (e.g., mapping data may have inaccuracies and calculations could be an over- or underestimation); (2) lack of current scientific data on how certain environmental changes affect species; and (3) reliance on other resource analyses also furthers the assumptions, uncertainties, and unknown information stated in those sections into this analysis.

3.8.3 Affected Environment

3.8.3.1 Relevant Laws, Regulations, Policies, and Plans

The primary Federal, State, and local policies, regulations, and guidelines used to analyze potential impacts on wildlife in the project analysis area are shown in the accompanying text box and further detailed in Newell (2018j).

Laws, Regulations, Policies, and Guidelines Used in the Wildlife Effects Analysis

- Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.)
- Migratory Bird Treaty Act of 1918, as amended (16 U.S.C. 703–711)
- National Forest Management Act implementing regulations (36 CFR 219.19(a)(1))
- Bald and Golden Eagle Protection Act of 1940, as amended (16 U.S.C. 668–668c)
- Bureau of Land Management – Phoenix Resource Management Plan, Las Cienegas National Conservation Area Resource Management Plan, and San Pedro Riparian National Conservation Area Resource Management Plan
- Arizona Game and Fish Department determinations of Species of Greatest Conservation Need (SGCN) occurring within the wildlife analysis area

3.8.3.2 Existing Conditions and Ongoing Trends

General Wildlife

A wide variety of general wildlife and associated habitats is found in or within 5 miles of the analysis area of all action alternatives. Section 3.3, Soils and Vegetation, describes the associated habitats. Many of the non-game wildlife species are considered by AGFD to be Species of Greatest Conservation Need (SGCN).[57] These species mostly overlap species with Federal special status (ESA, Tonto National Forest, or BLM) and are included under the “Special Status Wildlife Species” section. Several SGCN species that do not otherwise overlap Federal special status wildlife species are also included in the “Special Status Wildlife Species” section. We used biological surveys, as well as observations pulled from the AGFD’s Heritage Data Management System data, to determine which SGCN species have occurrence records within 5 miles of the action alternatives. We then evaluated SGCN for their likelihood of occurrence in Alternatives 2 and 3 (39 known to occur, 9 possible to occur); Alternative 4 (13 known to occur, 29 possible to occur); Alternative 5 (20 known to occur, 31 possible to occur); and Alternative 6 (19 known to occur, 30 possible to occur).

Game Species

A wide variety of Species of Economic and Recreational Importance (SERI), game species, and associated habitat occur within 5 miles of the action alternatives and are primarily addressed in the “Recreation” and “Socioeconomics” resource sections of this chapter. Section 3.3, Soils and Vegetation, shows the associated habitats. The footprint of the analysis area is located within AGFD’s Game Management Unit (GMU) 24A and 24B, where nine game species are present. Those species

57. Species of Greatest Conservation Need is a designation used by AGFD, as a means to focus planning and conservation efforts, particularly in the State Wildlife Action Plan.

include Gambel's quail (*Callipepla gambelii*), javelina (*Pecari tajacu*), cottontail (*Sylvilagus* spp.), mule deer (*Odocoileus hemionus*), white-tailed deer (*Odocoileus virginianus*), black bear (*Ursus americanus*), mountain lion (*Puma concolor*), bighorn sheep (*Ovis canadensis*), and tree squirrel (*Sciurus* spp.). Elk (*Cervus canadensis*) is also present in GMU 24A, but not in the portion of the GMU near or within the analysis area. Additionally, there are 10 SERI species with predicted occurrences within 5 miles of the project footprint. These species include mule deer, white-tailed deer, javelina, elk, black bear, mountain lion, Gambel's quail, mourning dove (*Zenaida macroura*), white-winged dove (*Zenaida asiatica*), and band-tailed pigeon (*Patagioenas fasciata*).

Special Habitat Areas

Special habitat areas include wildlife waters; Important Bird Areas; caves, mines, and karst features; and springs (figure 3.8.3-1). More information on caves/mines/karst features and springs is available in the "Geology, Minerals, and Subsidence" and "Groundwater Quantity and Groundwater-Dependent Ecosystems" sections of this chapter, respectively, and the habitats are described by biotic community in the "Soils and Vegetation" section. The Boyce Thompson Arboretum/Arnett-Queen Creeks Important Bird Area is located within 5 miles of the action alternatives but is only within the footprint of pipeline corridor options associated with Alternative 5 (see figure 3.8.3-1).

There are 15 wildlife waters (waters built or improved specifically for wildlife such as stock tanks and wildlife guzzlers) within 5 miles of the project footprint. Of these 15 wildlife waters, three would be within the project footprint. These wildlife waters include the Benson Spring, which would be within the footprint of the tailings facility for Alternatives 2 and 3; Silver King, which would be within the tailings facility area for Alternative 4; and Mineral Mountain, which would be within the west pipeline option for Alternative 5. Additionally, the Florence #1 wildlife water is about 50 feet south of the footprint for the south pipeline option of Alternative 6.

Caves, abandoned mines, and karst features in the analysis area may provide suitable roosting habitat for bat species. There are four caves, two mines, and four karst features within 5 miles of the project footprint. Only one of these, the Bomboy Mine, is within the project footprint. It is located within the footprint of the proposed tailings facility for Alternatives 2 and 3 (see figure 3.8.3-1). All of the remaining features are within 5 miles of all action alternatives and include the Umbrella Cave and the Superior High School Cave. Some of these features have been closed and bat gates have been installed to allow bat use of the features.

There are 338 springs mapped within 5 miles of the project footprint (see figure 3.8.3-1). This includes 24 springs and several stream segments that are considered to be groundwater dependent with the potential to be impacted by the project (see table 3.7.1-2); the specific list of groundwater-dependent ecosystems, including springs, perennial waters, and riparian areas that are believed to have a connection to regional aquifers and could potentially be impacted by the action alternatives, is the focus of the "Groundwater Quantity and Groundwater-Dependent Ecosystems" section of this chapter. Unlike the subset of springs analyzed in the "Groundwater Quantity and Groundwater-Dependent Ecosystems" section, the vast majority of springs shown in figure 3.8.3-1 were identified from available databases or literature sources and may or may not be physically present on the landscape, or they represent local seeps or springs without persistent water or a connection to regional aquifers. The wider springs inventory is included in this section because these water sources are still important to wildlife; however, many of these springs would not be impacted by project activities unless directly within the project footprint.

Wildlife Connectivity

Through resource management planning in recent years, agencies, organizations, stakeholders, academia, private citizens, and non-profit organizations all aided in identifying the important wildlife movement corridors throughout the state. During the development of the 2006 "Arizona's Wildlife Linkages Assessment" (Arizona Wildlife Linkages Workgroup 2006) and the 2013 "Pinal County Wildlife Connectivity Assessment: Report on Stakeholder Input" (Arizona Game and Fish

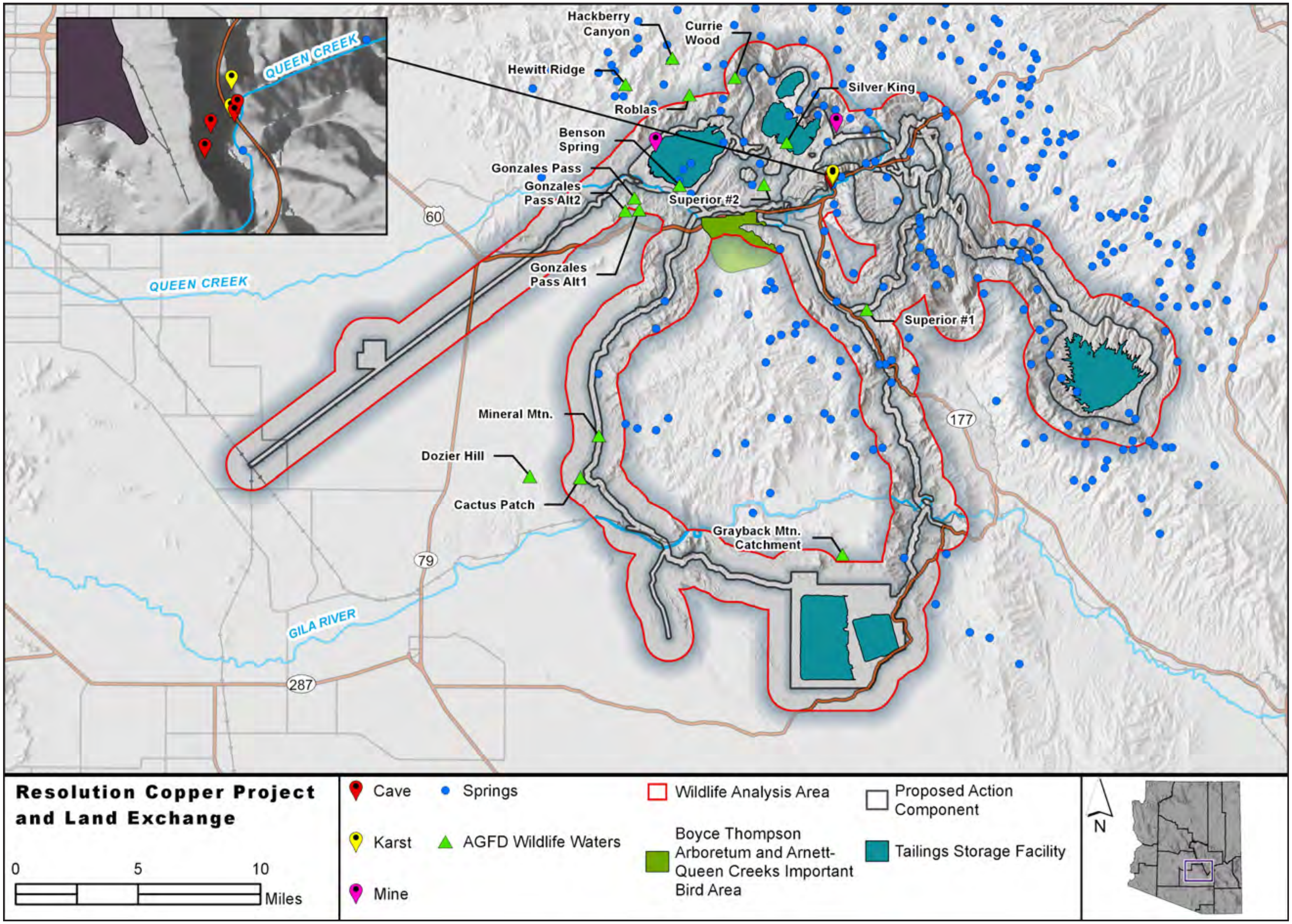


Figure 3.8.3-1. Special habitat areas, caves, mines, springs, and karst features

Department 2013), stakeholders identified numerous wildlife movement corridors, as well as natural topographic features such as canyons and washes that are used as animal movement corridors, as important to the conservation of species and their populations. Other researchers further analyzed and modeled some of these animal movement corridors to refine the best biological corridors (Beier et al. 2007). Additionally, habitat block areas were identified statewide as areas important for wildlife movement and landscape-scale connectivity. Category 1 blocks are the most intact and have no measurable human modification; Category 2 blocks are intact but may have some feature running through (Perkl 2013). Figure 3.8.3-2 depicts details of wildlife movement corridors within the vicinity of the analysis area and their geographical placement in the surrounding region. Figure 3.8.3-3 depicts landscape integrity in the vicinity of the analysis area. Additional detail can be found in the background documentation (see the "Wildlife Connectivity" section in Newell (2018j)).

Special Status Wildlife Species

For each action alternative, Federal and State special status wildlife species lists were analyzed, including the following:

- Federal
    - Endangered Species Act wildlife species listed in Pinal and Gila Counties
    - Migratory Bird Treaty Act (MBTA) species
    - Bald and Golden Eagle Protection Act (BGEPA) species
    - Tonto National Forest
        - Sensitive species
        - Migratory Bird Species of Concern
        - Management indicator species (MIS)
    - Bureau of Land Management
        - Sensitive species for the Tucson Field Office
- State
    - Arizona Game and Fish Department
        - Species of Greatest Conservation Need, if they had other status listings; two SGCN-only species were addressed at the request of the cooperating agency.

Additional detail regarding which species are known to occur or may possibly occur in the analysis area can be found in the background documentation (see table 3 in Newell (2018j)).

Management Indicator Species

The Forest Service is required to maintain viable populations of native and desired non-native species by evaluating a project's effects on selected MIS as set forth in the National Forest Management Act. Management indicator species are defined as follows: "Plant and animal species, communities, or special habitats selected for emphasis in planning, and which are monitored during forest plan implementation in order to assess the effects of management activities on their populations and the populations of other species with similar habitat needs which they may represent" (FSM 2620.5) (U.S. Forest Service 1991).

In order to meet the National Forest Management Act requirement to maintain viable populations of native and desired non-native species, MIS were selected based on a variety of criteria. In general, MIS were selected to serve as barometers of management effects on other species with similar habitat requirements. The Tonto National Forest has 30 MIS, which consist mostly of birds, to represent 30 habitat features (see table 4 in Newell (2018j)). Section 3.8.4 represents an analysis of current habitat and population trends of each MIS population within the Tonto National Forest, conducted as an interpretation of changes in populations and habitat trends since implementation of the 1985 forest plan for potential effects on MIS resulting from implementation of Tonto National Forest–approved projects. A forest-wide assessment titled

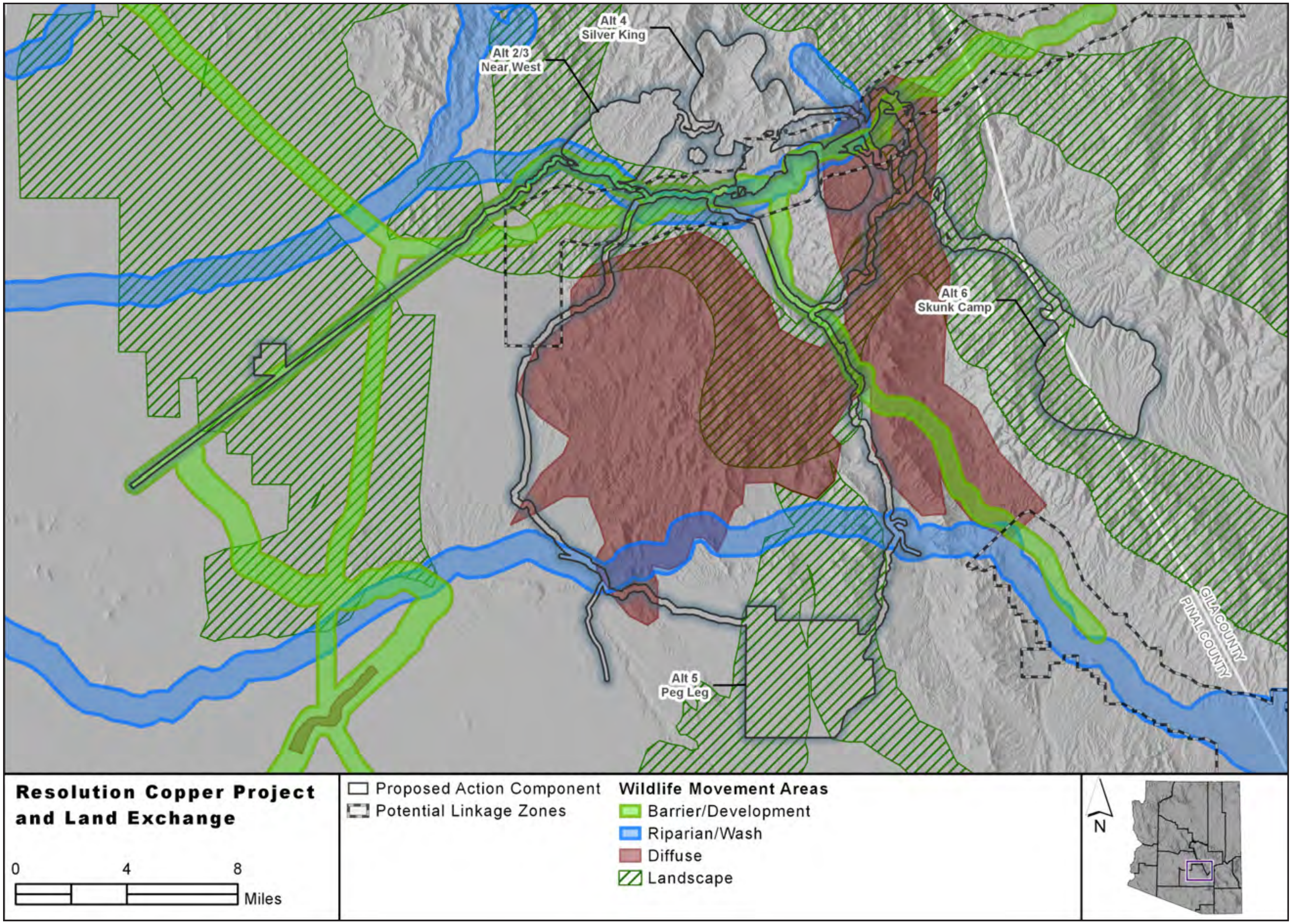


Figure 3.8.3-2. Wildlife movement areas

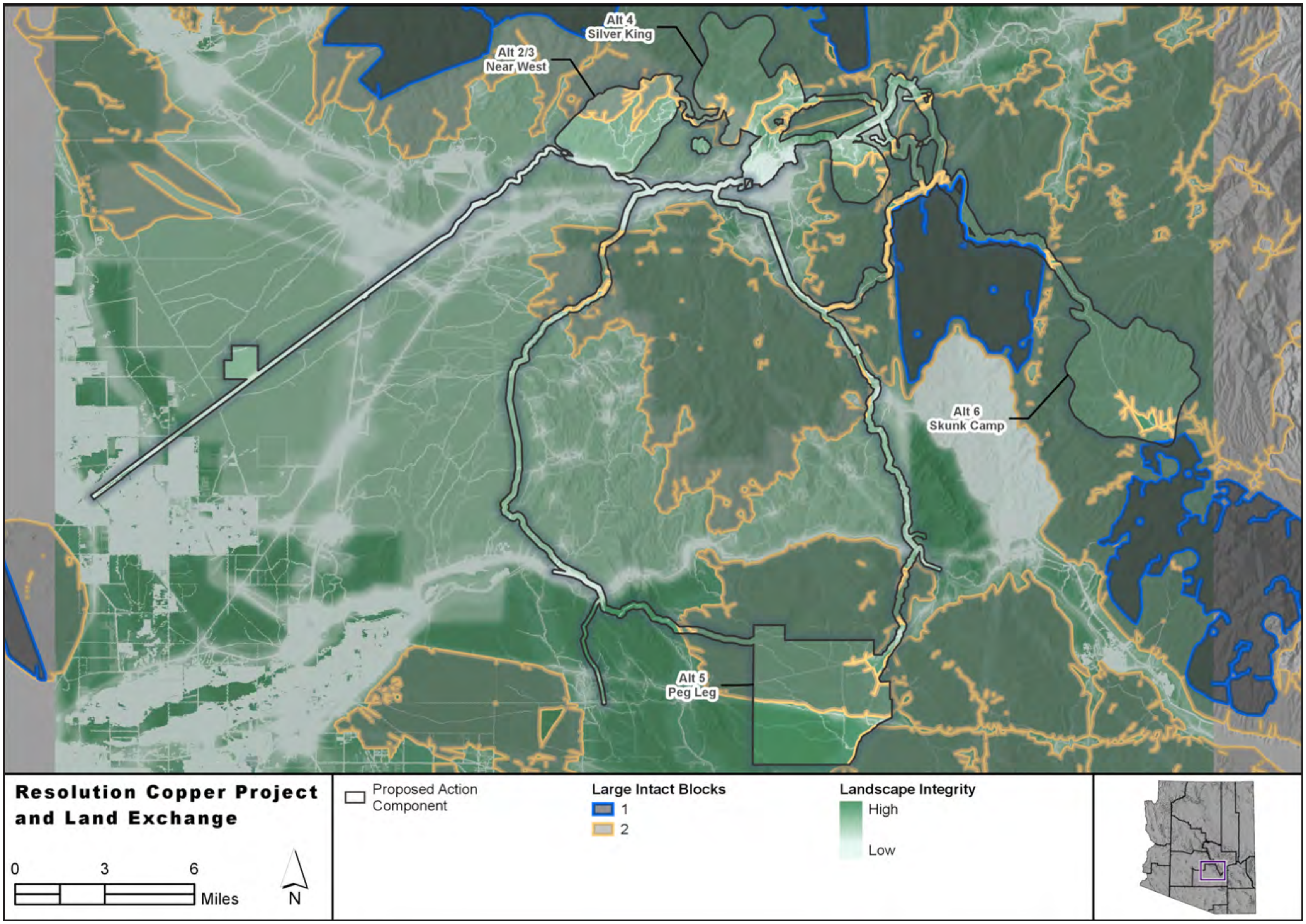


Figure 3.8.3-3. Landscape integrity

"Tonto National Forest Management Indicator Species Status Report" (Klein et al. 2005) summarizes current knowledge of population and habitat trends for MIS on the Tonto National Forest.

Habitats for a number of the Tonto National Forest MIS occur in the project area. As most MIS are not rare species, it is assumed that some individuals of each MIS associated with the habitat types in the project area are also present. Additionally, we expect that individuals of MIS associated with habitat not present within the project area have the potential to occur.

Additional detail regarding which MIS species are associated with each vegetation type or series, species trends, total acres on Tonto National Forest, and acres within the analysis area can be found in the background documentation (see table 4 in Newell (2018j)).

3.8.4 Environmental Consequences of Implementation of the Proposed Mine Plan and Alternatives

3.8.4.1 Alternative 1 – No Action Alternative

Under the no action alternative, the proposed project would not be constructed and potential impacts on wildlife resources (species and habitat) would not occur. Impacts on wildlife resources from existing disturbances (e.g., recreation, livestock grazing, mining and development, wildfires) would continue.

3.8.4.2 Impacts Common to All Action Alternatives

Effects of the Land Exchange

The selected Oak Flat Federal Parcel would leave Forest Service jurisdiction. The role of the Tonto National Forest under its primary authorities in the Organic Administration Act, Locatable Regulations (36 CFR 228 Subpart A), and Multiple-Use Mining Act is to ensure that mining activities minimize adverse environmental effects on National Forest System surface resources; this includes effects on the wildlife resources that may occur on the Oak Flat Federal Parcel. The removal of the Oak Flat Federal Parcel from Forest Service jurisdiction negates the ability of the Tonto National Forest to regulate effects on these resources or manage them to achieve desired conditions.

The offered lands would come under Federal jurisdiction. Specific management of the wildlife resources of those parcels would be determined by the agencies to meet desired conditions or support appropriate land uses. In general, these parcels contain a variety of ecosystems similar to those that support wildlife species in the analysis area, including riparian, xeroriparian, semi-desert grassland, and desert ecosystems, that would come under Federal jurisdiction.

Effects of Forest Plan Amendment

The Tonto National Forest Land and Resource Management Plan (1985b) provides guidance for management of lands and activities within the Tonto National Forest. It accomplishes this by establishing a mission, goals, objectives, and standards and guidelines. Missions, goals, and objectives are applicable on a forest-wide basis. Standards and guidelines are either applicable on a forest-wide basis or by specific management area.

A review of all components of the 1985 forest plan was conducted to identify the need for amendment due to the effects of the project, including both the land exchange and the proposed mine plan (Shin 2019). Of all resources, wildlife have the greatest number of standards and guidelines identified in the forest plan for consideration (37). None of these standards and guidelines were found to require amendment to the proposed project, either on a forest-wide or management area-specific basis. For additional details on specific rationale, see Shin (2019).

Summary of Applicant-Committed Environmental Protection Measures

A number of environmental protection measures are incorporated into the design of the project that would act to reduce potential impacts on

wildlife. These are non-discretionary measures and their effects are accounted for in the analysis of environmental consequences.

In the GPO, Resolution Copper has committed to a variety of measures to reduce potential impacts on wildlife, including those outlined in Section 4.7, “Wildlife,” and Appendix X, “Wildlife Management Plan,” of the GPO (Resolution Copper 2016c).

- Electric power transmission and distribution line towers (power poles) that serve the Resolution Copper Project facilities will be designed and constructed to avoid raptor electrocutions.
- Some additional non-lethal harassment and scare devices to deter and disperse wildlife from the PAG tailings, non-contact and contact stormwater catchment basins, and process water ponds may also be considered and could include the following:
    - Plastic ball covers, vehicle lights and horns, motion-sensor lights, flags, perch deterrents, shell crackers, bird bangers, screamers, distress cries/electronic noise systems, bird scare balloons, propane cannons, and mylar scare tape.
    - A bird hazing protocol would be developed for Resolution Copper employees and would include a combination of harassment techniques. Additional hazing techniques may be adjusted or added as necessary based on field observations and ongoing research efforts. The protocol would include an inspection schedule, acceptable harassment techniques, a field log procedure, and incident reporting procedures. Resolution Copper staff responsible for implementing the bird hazing program would be trained on the protocol prior to its initiation.
- Vegetation growth within the contact and non-contact stormwater catchment basins and process water ponds would be monitored and periodically removed as often as necessary to further discourage the presence of wading birds.

Other applicant-committed environmental protection measures by Resolution Copper to reduce impacts on wildlife include measures adapted from previous investigations on the Tonto National Forest:

- Conducting pre-construction surveys for Sonoran desert tortoise (*Gopherus morafkai*) and Gila monster (*Heloderma suspectum*) before surface ground-disturbing activities start. A biological monitor would monitor for Sonoran desert tortoise and Gila monster during construction activities. The monitor would flag Sonoran desert tortoise and Gila monster shelter sites/burrows. These flagged areas would be inspected, and any Gila monsters and tortoises discovered would be relocated outside of project activity areas;
- Informing project crews of the potential to encounter Sonoran desert tortoise and Gila monster within the surface project area. Work crews would be instructed to check below equipment prior to moving, and to cover and/or backfill holes that could potentially entrap these species. If these species are observed, work crews would stop work until the biological monitor has relocated these species out of harm’s way; and
- Establishing tortoise crossings for concentrate and tailings pipeline corridors in areas containing habitat.

General Construction Impacts

Potential construction-related impacts from all action alternatives common to all wildlife groups, including special status wildlife species, would involve the loss, degradation, and/or fragmentation of breeding, rearing, foraging, and dispersal habitats; collisions with and crushing by construction vehicles; loss of burrowing animals in burrows in areas where grading would occur; increased invasive and noxious weed establishment and spread; increased edges of vegetation blocks; and impacts from increased noise/vibration levels. Proposed construction activities would include the loss, degradation, and fragmentation of habitat for wildlife and special status wildlife species

during ground-clearing activities. Ground-clearing activities include construction of access roads, pipeline corridors, tailings facilities, and other project facilities. Construction activities would also affect adjacent habitats and connectivity between habitats as project features would create barriers to wildlife movement and dispersal.

Ground disturbance associated with construction activities may increase the potential for the introduction and colonization of disturbed areas by noxious and invasive plant species. This may lead to changes in vegetation communities and thus habitat for wildlife, including a possible shift over time to more wildfire-adapted non-native vegetation. These potential changes would impact species as habitat is modified and degraded and could decrease suitability of areas to support breeding, rearing, foraging, and dispersal of wildlife and special status wildlife species.

Temporary impacts associated with the presence of workers and equipment may cause species to avoid using work areas or adjacent habitats during construction activities. Some construction activities would overlap operations for approximately 6 years, during which noise- and vibration-producing activities would be ongoing. Potential impacts related to noise and vibration would be temporary and would diminish with the completion of construction activities.

Noise and vibration associated with construction activities may temporarily change habitat use patterns for some species. Many wildlife species rely on meaningful sounds for communication, navigation, finding food, and to avoid danger (Federal Highway Administration 2004). Some individuals would likely move away from the source(s) of the noise/vibration to adjacent or nearby habitats, which may alter or affect competition for resources within these areas. Noise/vibration and other disturbances may also lead to increased stress on individuals, impacting their overall fitness due to increased metabolic expenditures.

Additional noise and vibration impacts may include decreased immune response, hearing damage, diminished intraspecific communication, increased predation risk, and reduced reproductive success (NoiseQuest 2011; Pater et al. 2009; Sadlowski 2011). These effects would be temporary and of short duration and would diminish with the completion of construction activities. Some species could see impacts on local populations in the action area, but no regional population level impacts are likely.

The proposed project would increase the amount of edge habitat along areas to be disturbed, especially along linear features such as pipeline corridors, electrical distribution lines, and access roads. Effects from increased amounts of edge would include decreased habitat block size. Decreased habitat block size may negatively impact those species that require large blocks of contiguous habitat and benefit other species that use edge habitats or have more general habitat requirements. In areas where there is higher vegetation density, the potential impacts from habitat fragmentation and edge effects would be greatest.

Artificial lighting associated with the construction phase of the proposed project is less defined but is assumed to be less intense that associated with the operations phase, and to vary in location and intensity through the 1- to 9-year time period. Specific impacts would be similar to those describe in the “General Operations Impacts” section; impacts on species groups are discussed in subsequent sections.

General Operations Impacts

Potential impacts on wildlife and special status wildlife species during the operations phase of all action alternatives would be associated with subsidence; potential reduction in surface water flows and groundwater availability to support riparian habitats; habitat changes from ongoing noxious and invasive weed establishment and spread; and the ongoing presence of workers and equipment.

During the operations phase of the proposed mine, there would be impacts on wildlife and special status wildlife species from subsidence. Subsidence of the ground surface is anticipated to occur at approximately 6 years after initiation of mining activities and is anticipated to continue until 41 years after initiation of mining activities (see Section 3.2, Geology, Minerals, and Subsidence).

Within the cave limit, the development of a subsidence area would change the slope, aspect, surface water flow direction and rate; surface

elevation; and would impact habitat on approximately 1,329 acres. This could lead to mortality of wildlife species individuals within the subsidence area during caving/fracture events. Within the fracture limit (1,579 acres) the potential impacts would be similar to the cave limit; however, the intensity would be decreased as this area would have reduced surface impacts. The continuous subsidence limit (1,687 acres) would have limited potential for localized impacts on vegetation communities as it would have minimal surface impacts. The entire subsidence area would be fenced for public safety and would remove the subsidence area as habitat for some wildlife and special status wildlife species. Smaller species and avian species would be able to use the subsidence area as habitat.

Potential water usage associated with operation of all action alternatives would reduce water in the regional aquifer and may reduce surface water and groundwater levels downstream of the mine in Devil's Canyon and Queen Creek. Surface water amounts would be reduced, and timing/persistence of surface water would decrease. These potential decreases in groundwater and surface water would occur over a long period of time but could cause changes in riparian vegetation extent or health, and the potential reduction in stream flow could impact species that use these riparian areas during portions of their life cycle. Potential impacts may reduce or remove available habitat for wildlife and special status wildlife species and impact individuals in localized areas along Devil's Canyon and Queen Creek, or around springs. These impacts are not anticipated to affect flow regimes or riparian habitat along the Gila River (see section 3.7.1 for a more detailed discussion of impacts on groundwater-dependent ecosystems and riparian areas).

We do not anticipate any impacts on wildlife or special status wildlife species from water quality impacts at any of the tailings locations during operations, as any stormwater that comes in contact with the tailings piles would be contained in the tailings facilities or in seepage ponds downstream. It is possible that avian species could use the seepage ponds. We expect concentrations of some constituents in the seepage ponds to be above chronic exposure limits and some acute exposure limits from some constituents under all action alternatives (cadmium, copper, nickel, selenium, zinc, and silver). This could lead to short- and long-term impacts on some avian species if they are exposed to water from the seepage ponds; the potential to impact these species would be greatest if they were exposed over an extended period of time. See the "Screening of Geochemistry Predictions for Effects on Wildlife Process Memorandum" for more information (Newell 2018k).

Potential impacts on wildlife and special status wildlife species habitat from increased noxious and invasive weed establishment and spread would be similar in nature to those described above for construction; however, as ground-disturbing activities would be reduced during operations, the magnitude of potential impacts would be reduced.

Potential impacts on wildlife and special status wildlife species from the presence of workers and equipment would be similar in nature to those described above for construction. However, the magnitude of impacts would be reduced as the numbers of workers and equipment would be less than during the construction phase.

Lighting associated with the operations phase of the proposed project may lead to changes in the interaction between pollinators and some plant species (Bennie et al. 2016). This may lead to decreases in forage resources for some species. Light may attract insects and increase the density of forage for some insectivorous bat species. These impacts would be greatest near light sources and would decrease with distance from the sources.

Artificial lighting associated with the operations phase of the proposed project would increase overall brightness in the night sky by 1 percent to 9 percent; therefore, impacts on wildlife species may occur. However, these impacts are not well understood or researched in current literature since much of the literature focuses on non-LED lights. Additionally, the potential impacts, if realized, would be associated within the direct vicinity of the main operations areas, i.e., where the most lights are concentrated to increase overall night-sky brightness. The potential impacts from light would reduce with distance from the light source and could lead to changes in migration or dispersal behavior including species avoiding the lighted area. It is likely that species would be avoiding the lit areas for multiple reasons, such as loss or degradation

of habitat and human presence. Specific impacts on species groups are provided in subsequent sections.

General Closure and Reclamation Impacts

Closure and reclamation activities would increase vegetative cover in areas of project-related disturbance to some extent, depending on reclamation success (discussed in more detail in Section 3.3, Soils and Vegetation). Within reclaimed/revegetated areas there would be a greater potential for an improvement in habitat conditions from the increase in vegetative cover, native vegetative cover, and a reduction in soil erosion potential. While vegetative cover would likely increase, there are constraints that make it unlikely to fully meet desired conditions for the landscape, or for pre-project conditions to be achieved through reclamation/revegetation activities. Wildlife and special status wildlife species habitat in these areas would not return to pre-project conditions.

Additional Impacts Specific to Wildlife Groups

MAMMALS

Small mammals that shelter underground would be susceptible to being crushed or struck by construction equipment.

Artificial night lighting can increase the risk of predation and decrease food consumption for small, herbivorous, nocturnal mammals. Circadian rhythm and melatonin production in mammals are likely affected by artificial night lighting. Increased artificial night lighting may also increase roadkill and disrupt mammalian dispersal movements and wildlife corridor use (Beier 2006). Project-related light may attract insects and increase the density of forage for some insectivorous bat species. These impacts would be greatest near light sources and would decrease with distance from the sources. The proposed use of LED lights may impact fast-flying species—like Brazilian free-tailed bats (*Tadarida brasiliensis*), California leaf-nosed bat (*Macrotus californicus*), and spotted bat *(Euderma maculatum*)—more than slower flying species, like cave myotis (*Myotis velifer*) (Stone et al. 2012). The increased artificial lighting at night may result in a lower food intake for some bat species and possibly lower reproductive success for some species of aerial-hawking bats (i.e., prey is pursued and caught in flight). Conversely, there is the potential that increased artificial night lighting may be beneficial to some bat species, for at least some aspects of their natural history (Fenton and Morris 1976). Moth capture rate may increase since the moth's bat detection system is turned off in light (Frank 2006; Rydell 2006).

Bat species could experience effects from removal of foraging habitat and impacts on roosts and breeding activities by noise and vibration from blasting activities (Siemers and Schaub 2011). Potential impacts on bat species may include causing adult bats to leave maternity roosts during daytime hours. This could lead to infant bats being dropped or knocked to the ground, resulting in mortalities.

BIRDS

Additional impacts on special status bird species would include temporary disturbance from noise as well as changes to habitat use. Noise-related construction activities could affect nesting, roosting, and foraging activities. Changes to behavior could include increased alertness, turning toward the disturbance, fleeing the disturbance, changes in activity patterns, and nest abandonment. Raptors could be especially susceptible to noise disturbance early in the breeding season, through nest abandonment and reduction in overall success.

Potential impacts from operations and maintenance would be from potential electrocution of birds and from striking electrical distribution lines. While some individuals could be impacted, these impacts would be minor and long term and unlikely to reach population levels. Small and mobile bird species would be anticipated to have a very low potential for collisions. The presence of electrical distribution poles would provide perches (for perching and foraging) as well as nesting habitat for some species and could increase impacts on prey species nearby. Unintentional take from these impacts would not significantly impact local, regional, or overall populations of migratory birds.

The increased amount of edge habitat created by the proposed project would allow for an increase in species potential for nest parasitism and depredation due to increased diversity of species and less nest concealment in the edge habitat (Paton 1994; Winter et al. 2000). Other species that use edge habitats or have more general habitat requirements would benefit from the increased amount of edge habitat. In areas where there is higher vegetation density, the potential impacts from habitat fragmentation and edge effects would be greatest. This would change the species composition near project facilities and impact species that use larger blocks of habitat, as they would be subject to increased predation and potential for nest parasitism. Unintentional take from these impacts would not significantly impact local, regional, or overall populations of migratory birds.

Impacts on migrating birds from artificial light increases at night can range from death or injury from collisions with structures, to reduced energy stores due to delays or altered routes, and delayed arrival at breeding grounds (Gauthreraux Jr. and Belser 2006). Unintentional take from these impacts would not significantly impact local, regional, or overall populations of migratory birds.

For all impacts on migratory birds from construction, operations, and maintenance activities of each alternative, unintentional take would likely impact local migratory bird populations, yet would vary by species due to life history traits and habitat use. However, impacts on regional and overall migratory bird populations would likely be negligible. The potential acreages of impacts on migratory bird priority habitats are provided in table 3.8.4-2 later in this section. Additionally, the Boyce Thompson Important Bird Area (see figure 3.8.3-1) is located within the analysis area.

FISH

Additional impacts on fish species include mortality from loss or modification of habitat due to changes in surface water levels or flows, including changes due to changes in groundwater elevation and contribution to surface flows. These impacts would occur for all action alternatives and would have the greatest potential to impact fish species along areas of Devil’s Canyon and Queen Creek that currently have surface flows. Any impacts would be to non-native fish populations as no native fish are known to occur in sections of Devil’s Canyon and Queen Creek that have surface flows. This is not anticipated to impact habitat for longfin dace (*Agosia chrysogaster*) and other species in Mineral Creek (WestLand Resources Inc. 2018a) as no reductions in flows from the proposed project are anticipated.

Artificial light increases at night are not likely to impact fish since lighting is unlikely to increase in the analysis area near their habitats; however, the exact project lighting layout is not yet known. Potential impacts on fish from artificial light could include breakdowns in niche portioning, changes in migratory patterns, temporary blindness, alternations of predator–prey relations, and changes to foraging behavior (Nightingale et al. 2006).

REPTILES

Reptile species that shelter underground would be susceptible to being crushed by construction equipment. Construction-related trash may attract reptile predators such as ravens (*Corvus corax*) and other predators. The presence of the electrical distribution lines and poles could provide perching and nesting habitat for ravens and other species, which may increase raven and other reptile predator numbers along electrical distribution lines. Knowledge of potential negative effects from artificial light on most reptile species, other than sea turtles, is limited and somewhat speculative. Potential impacts include an extended photoperiod, which can also be positive for some species like geckos and possibly the Bezy’s night lizard (*Xantusia bezyi*) (Perry and Fisher 2006).

AMPHIBIANS

Amphibian species would also be affected by changes to water quality and quantity. These impacts would occur for all action alternatives and would have the greatest potential to impact amphibian species along areas of Devil’s Canyon and Queen Creek that currently have

perennial surface flows that would be reduced by changes in runoff or groundwater contribution. Artificial light increases at night are not likely to impact amphibians since lighting is unlikely to increase in the analysis area near their habitats; however, the exact project lighting layout is not yet known. Possible impacts could include changes to predator–prey relationships, changes in reproduction, and inter-specific (between different species) competition and intra-specific (between individuals of same species) competition for prey (Buchanan 2006).

INVERTEBRATES

Potential impacts on invertebrates from the proposed project would include those described earlier in this section as "Impacts Common to All Action Alternatives." Aquatic invertebrate species would also be affected by changes to water quality and quantity. These impacts would occur for all action alternatives and would have the greatest potential to impact aquatic invertebrate species along areas of Devil's Canyon and Queen Creek that currently have surface flows. Invertebrates that use vibrational communication systems would also be affected by increases in ground-borne vibrations through substrates and soils. These impacts would occur for all action alternatives near any blasting and heavy machinery operations. Artificial light at night may lead to changes in the interaction between pollinators and some plant species, such as cacti (Bennie et al. 2016). This may lead to decreases in forage resources for some species in all groups. In addition, artificial light may increase moth (Order Lepidoptera) predation by bats and birds (Frank 2006).

Wildlife Connectivity

Impacts on animal movement corridors from any of the action alternatives would include direct effects due to a long-term loss of movement habitat from construction and mining activities and/or the construction of project facilities within those corridor areas, as well as a long-term movement habitat loss along pipeline corridors since vegetation would be expected to eventually reestablish in the disturbed areas but would be unlikely to return to pre-construction conditions. Project activities could potentially change predator–prey interactions and would increase the degree of habitat fragmentation within the species' ranges, which in turn can disrupt localized and long-distance dispersal and migration events. In addition, increased human presence in the region from mining activities would lead to temporary disturbances of individual species, affecting movement patterns. Furthermore, indirect impacts on gene flow and biodiversity could occur from any of the action alternatives; however, these impacts would be temporary and insignificant since these biological processes occur over multi-generational time periods, which are typically longer for most species than the proposed life of the mine (Brown Jr. and Gibson 1983; Slatkin 1987). Some of these alternatives would result in minor impacts with others resulting in major impacts. Potential impacts on habitat blocks are given in table 3.8.4-1 and are broken out by alternative and project components.

Differences Between Alternatives 2 through 6

Potential impacts on wildlife species from the action alternatives would generally be as described earlier in this section. Table 3.8.4-2 presents special status wildlife species that potentially occur within the analysis area of each action alternative. (The directions in the alternative options [i.e., "West," "East," "South," and "North" in table 3.8.4-2] refer to the proposed pipeline corridor alignments under consideration for each alternative.) These impacts are discussed more in the next section, "Impacts on Special Status Wildlife Species."

Table 3.8.4-3 provides the MIS species trends, total acres on Tonto National Forest, and acres associated with each action alternative. (The directions in the alternative options [i.e., "East," "West," "South," and "North" in table 3.8.4-3] refer to the proposed pipeline corridor alignments under consideration for each alternative.) The action alternatives are not anticipated to change the current MIS species trends based on the low percentage of acres that would be impacted.

Table 3.8.4-1. Acres of habitat blocks potentially affected for all action alternatives

Alternative	Alternative Component	Habitat Block 1 Acres Affected	Habitat Block 2 Acres Affected
2	East Plant Site/Subsidence areas	–	1,226
2	Near West fence line	–	487
2	Tailings facility	–	789
2	Near West tailings corridor	–	56
2	West Plant Site	–	20
3	East Plant Site/Subsidence areas	–	1,226
3	Fence and tailings storage facility	–	1,275
3	Near West fence line	–	457
3	Tailings facility	–	819
3	Near West tailings corridor	–	56
3	West Plant Site	–	20
4	East Plant Site/Subsidence areas	–	1,226
4	Silver King tailings corridor	–	24
4	Silver King fence line	–	2,880
4	Tailings facility	–	1,849
4	West Plant Site	–	20
5 east option	East Peg Leg tailings corridor	–	118
5 east option	East Plant Site/Subsidence areas	–	1,226
5 east option	Peg Leg fence line	–	2,843
5 east option	Tailings facility	–	3,264
5 east option	West Plant Site	–	20
5 west option	East Plant Site/Subsidence areas	–	1,226
5 west option	Peg Leg fence line	–	2,843
5 west option	Tailings facility	–	3,264
5 west option	West Peg Leg tailings corridor	–	295
5 west option	West Plant Site	–	20
6 north option	Access roads	3	44
6 north option	North Skunk Camp tailings corridor	60	966
6 north option	Skunk Camp transmission line corridor	22	320
6 north option	Skunk Camp fence line	59	5,827
6 north option	East Plant Site/Subsidence areas	–	1,226
6 north option	Tailings facility	–	3,750

continued

Table 3.8.4-1. Acres of habitat blocks potentially affected for all action alternatives *(cont'd)*

Alternative	Alternative Component	Habitat Block 1 Acres Affected	Habitat Block 2 Acres Affected
6 north option	West Plant Site	–	20
6 south option	Access roads	3	41
6 south option	Skunk Camp transmission line corridor	22	320
6 south option	Skunk Camp fence line	59	5,827
6 south option	South Skunk Camp tailings corridor	60	941
6 south option	East Plant Site/Subsidence areas	–	1,226
6 south option	Tailings facility	–	3,750
6 south option	West Plant Site	–	20

Source: Morey (2018a)

Table 3.8.4-2. Acres of modeled habitat for special status wildlife species that potentially would be impacted under each action alternative

Common Name (Scientific Name)	Status	Alternative 2	Alternative 3	Alternative 4	Alternative 5 West Pipeline Option	Alternative 5 East Pipeline Option	Alternative 6 South Pipeline Option	Alternative 6 North Pipeline Option
Amphibians								
Lowland leopard frog (*Lithobates yavapaiensis*)	TNF: S AGFD: SGCN 1A	139,011	151,795	153,738	277,160	288,425	268,300	252,059
Birds								
Northern goshawk (*Accipiter gentilis*)	TNF: S, MBSC AGFD: SGCN 1B MBTA: Yes	0	0	545	0	0	9,962	9,962
Western burrowing owl (*Athene cunicularia hypugaea*)	BLM: S AGFD: SGCN 1B MBTA: Yes	150,167	150,829	150,280	223,443	160,847	145,064	144,532
Golden eagle (*Aquila chrysaetos*)	TNF: MBSC AGFD: SGCN 1B MBTA: Yes BGEPA: Yes	169,976	182,775	184,327	305,938	299,168	298,884	282,643
Juniper titmouse (*Baeolophus ridgwayi*)	TNF: MBSC AGFD: SGCN 1C MBTA: Yes	90,252	92,912	105,271	84,679	106,106	188,677	178,356
Ferruginous hawk (*Buteo regalis*)	BLM: S AGFD: SGCN 1B MBTA: Yes	63,718	63,739	70,094	79,557	71,092	113,242	113,490
Swainson's hawk (*Buteo swainsoni*)	TNF: MBSC AGFD: SGCN 1C MBTA: Yes	23,076	23,076	29,451	25,555	30,459	72,609	72,857
Common black hawk (*Buteogallus anthracinus*)	TNF: MBSC AGFD: SGCN 1C MBTA: Yes	45,492	51,126	46,368	44,552	46,346	73,813	73,813
Costa's hummingbird (*Calypte costae*)	TNF: MBSC AGFD: SGCN 1C MBTA: Yes	254,041	267,466	259,021	434,175	406,218	366,813	350,571
Northern beardless-tyrannulet (*Camptostoma imberbe*)*	TNF: MBSC AGFD: N/A MBTA: Yes	8,517	8,517	9,348	16,023	15,664	15,803	15,334
Western yellow-billed cuckoo (Distinct Population Segment) (*Coccyzus americanus*)	ESA: T (All Arizona counties) TNF: MBSC AGFD: SGCN 1A MBTA: Yes	18,804	18,860	19,177	50,948	54,785	43,101	43,101

continued

Table 3.8.4-2. Acres of modeled habitat for special status wildlife species that potentially would be impacted under each action alternative *(cont'd)*

Common Name (Scientific Name)	Status	Alternative 2	Alternative 3	Alternative 4	Alternative 5 West Pipeline Option	Alternative 5 East Pipeline Option	Alternative 6 South Pipeline Option	Alternative 6 North Pipeline Option
Gilded flicker (*Colaptes chrysoides*)	TNF: MBSC AGFD: SGCN 1B MBTA: Yes BLM: S	240,199	252,812	241,561	420,375	392,419	340,300	323,811
Olive-sided flycatcher (*Contopus cooperi*)*	TNF: MBSC AGFD: SGCN 1C MBTA: Yes	503	1,006	611	590	646	1,420	1,324
Broad-billed hummingbird (*Cynanthus latirostris*)	AGFD: SGCN 1B MBTA: Yes BLM: S	195,997	209,318	199,917	375,907	347,951	314,209	297,967
Cordilleran flycatcher (*Empidonax occidentalis*)	TNF: MBSC AGFD: SGCN 1C MBTA: Yes	0	0	0	0	0	9,749	9,749
Southwestern willow flycatcher (*Empidonax traillii extimus*)	ESA: E (All AZ counties except Navajo) AGFD: SGCN 1A MBTA: Yes BLM: S	32,605	34,233	46,463	125,488	146,541	151,143	138,834
Gray flycatcher (*Empidonax wrightii*)	TNF: MBSC AGFD: SGCN 1C MBTA: Yes	56,471	60,690	61,494	96,201	108,705	132,158	127,975
Prairie falcon (*Falco mexicanus*)	TNF: MBSC AGFD: SGCN 1C MBTA: Yes	8,517	8,517	9,348	16,023	15,664	15,803	15,334
American peregrine falcon (*Falco peregrinus anatum*)	TNF: S, MBSC AGFD: SGCN 1A MBTA: Yes	259,841	273,266	274,192	439,319	411,363	388,746	372,504
MacGillivray's warbler (*Geothlypis tolmiei*)*	TNF: MBSC AGFD: SGCN 1B MBTA: Yes	8,331	16,660	7,889	15,750	15,408	7,625	7,168
Pinyon jay (*Gymnorhinus cyanocephalus*)*	TNF: MBSC AGFD: SGCN 1B MBTA: Yes	0	0	0	0	0	2	22

continued

Table 3.8.4-2. Acres of modeled habitat for special status wildlife species that potentially would be impacted under each action alternative *(cont'd)*

Common Name (Scientific Name)	Status	Alternative 2	Alternative 3	Alternative 4	Alternative 5 West Pipeline Option	Alternative 5 East Pipeline Option	Alternative 6 South Pipeline Option	Alternative 6 North Pipeline Option
Bald eagle (*Haliaeetus leucocephalus*)	TNF: MBSC AGFD: SGCN 1A MBTA: Yes BGEPA: Yes	206,000	218,910	219,310	258,082	272,946	330,810	318,662
Lewis's woodpecker (*Melanerpes lewis*)*	TNF: MBSC AGFD: SGCN 1C MBTA: Yes	7,955	15,909	7,509	15,356	15,015	7,187	6,748
Gila woodpecker (*Melanerpes uropygialis*)	TNF: MBSC AGFD: SGCN 1B MBTA: Yes	254,994	267,606	266,142	435,079	407,122	374,336	358,095
Canyon towhee (*Melozone fusca*)	TNF: MBSC MBTA: Yes	8,517	8,517	9,347	16,023	15,664	15,803	15,334
Elf owl (*Micrathene whitneyi*)	TNF: MBSC AGFD: SGCN 1C MBTA: Yes	251,610	264,222	256,590	431,743	403,787	366,909	350,668
Lucy's warbler (*Oreothlypis luciae*)	TNF: MBSC AGFD: SGCN 1C MBTA: Yes	259,841	273,266	274,192	439,319	411,363	384,321	368,079
Phainopepla (*Phainopepla nitens*)*	TNF: MBSC AGFD: SGCN 1C MBTA: Yes	7,955	15,909	7,509	15,357	15,015	7,187	6,748
Desert purple martin (*Progne subis hesperia*)	TNF: MBSC AGFD: SGCN 1B MBTA: Yes	238,577	252,002	253,304	418,431	390,475	365,426	349,184
Flammulated owl (*Psiloscops flammeolus*)	TNF: MBSC AGFD: SGCN 1C MBTA: Yes	0	0	0	0	0	9,962	9,962
Black-throated gray warbler (*Setophaga nigrescens*)	TNF: MBSC AGFD: SGCN 1C MBTA: Yes	9,347	9,347	8,517	16,023	15,664	15,803	15,334
Yellow warbler (*Setophaga petechia*)	TNF: MBSC AGFD: SGCN 1B MBTA: Yes	164,318	177,476	177,930	219,315	233,585	259,434	247,906
Red-naped sapsucker (*Sphyrapicus nuchalis*)	TNF: MBSC AGFD: SGCN 1C MBTA: Yes	72,919	74,408	89,410	100,948	106,449	167,307	167,840

continued

Table 3.8.4-2. Acres of modeled habitat for special status wildlife species that potentially would be impacted under each action alternative *(cont'd)*

Common Name (Scientific Name)	Status	Alternative 2	Alternative 3	Alternative 4	Alternative 5 West Pipeline Option	Alternative 5 East Pipeline Option	Alternative 6 South Pipeline Option	Alternative 6 North Pipeline Option
Black-chinned sparrow (*Spizella atrogularis*)	TNF: MBSC AGFD: SGCN 1C MBTA: Yes	92,698	95,358	107,717	88,994	108,945	196,103	185,249
Bendire's thrasher (*Toxostoma bendirei*)*	TNF: MBSC AGFD: SGCN 1C MBTA: Yes	6,907	13,812	7,576	14,317	13,937	12,250	11,805
Arizona Bell's vireo (*Vireo bellii arizonae*)	TNF: MBSC AGFD: SGCN 1B MBTA: Yes	226,931	240,317	241,282	376,364	374,734	355,528	339,287
Gray vireo (*Vireo vicinior*)	TNF: MBSC AGFD: SGCN 1C MBTA: Yes	94,700	99,713	109,719	86,104	108,197	197,403	187,251
Fish								
Gila longfin dace (*Agosia chrysogaster*)	AGFD: SGCN 1B	18,848	20,252	24,618	61,308	69,802	58,380	47,108
Gila chub (*Gila intermedia*)	ESA: E (Cochise, Coconino, Gila, Graham, Greenlee, Pima, Pinal, Santa Cruz, and Yavapai Counties) BLM: S AGFD: SGCN 1A	1,323	1,323	1,323	1,148	1,334	1,416	1,369
Insects								
Monarch butterfly (*Danaus plexippus* pop. 1)*	TNF: OSI BLM: S	8,380	16,760	9,217	15,807	15,472	15,566	15,109
Mammals								
Pale Townsend's big-eared bat (*Corynorhinus townsendii pallescens*)	TNF: S AGFD: SGCN 1B	259,841	273,266	274,192	439,319	411,363	388,746	372,504
Spotted bat (*Euderma maculatum*)	TNF: S AGFD: SGCN 1B	259,841	273,266	274,192	434,871	409,139	386,522	370,280

continued

Table 3.8.4-2. Acres of modeled habitat for special status wildlife species that potentially would be impacted under each action alternative *(cont'd)*

Common Name (Scientific Name)	Status	Alternative 2	Alternative 3	Alternative 4	Alternative 5 West Pipeline Option	Alternative 5 East Pipeline Option	Alternative 6 South Pipeline Option	Alternative 6 North Pipeline Option
Greater western mastiff bat (*Eumops perotis californicus*)	BLM: S AGFD: SGCN 1B	259,841	273,266	274,192	439,319	411,363	388,746	372,504
Allen's lappet-browed or big-eared bat (*Idionycteris phyllotis*)	TNF: S AGFD: SGCN 1B	5,914	5,914	9,809	5,524	5,524	6,275	6,505
Western red bat (*Lasiurus blossevillii*)	TNF: S AGFD: SGCN 1B	120,106	128,252	132,605	160,078	176,133	214,056	211,036
Lesser long-nosed bat (*Leptonycteris curasoae yerbabuenae*)	BLM: S AGFD: SGCN 1A	259,298	272,723	264,428	438,824	410,867	378,219	361,978
California leaf-nosed bat (*Macrotus californicus*)	AGFD: SGCN 1B	247,233	260,658	250,771	416,698	399,455	354,650	338,161
Cave myotis (*Myotis velifer*)	BLM: S AGFD: SGCN 1B	259,841	273,266	274,192	439,319	411,363	388,746	372,504
Brazilian free-tailed bat (*Tadarida brasiliensis*)[†]	SGCN 1B	259,841	273,266	274,192	439,319	411,363	388,746	372,504
Reptiles								
Sonoran Desert tortoise (*Gopherus morafkai*)	TNF: S AGFD: SGCN 1A BLM: S	240,569	253,991	252,751	420,098	392,699	362,054	345,812
Bezy's night lizard (*Xantusia bezyi*)	TNF: S AGFD: SGCN 1B	122,542	128,630	136,893	122,956	154,511	244,038	227,966

Status Definitions

Tonto National Forest (TNF):

S = Sensitive. Species identified by a Regional Forester for which population viability is a concern, as evidenced by: a) significant current or predicted downward trends in population number or density; b) significant current or predicted downward trends in habitat capability that would reduce a species' existing distribution.

OSI = Other Species of Interest. A plant or animal that was included in the analysis for which there are concerns about potential impacts in the region.

MBSC = Migratory Bird Species of Concern

Endangered Species Act (ESA):

E = Endangered. Endangered species are those in imminent jeopardy of extinction. The ESA specifically prohibits the take of a species listed as endangered. Take is defined by the ESA as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to engage in any such conduct.

T = Threatened. Threatened species are those that are likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

Arizona Game and Fish Department (AGFD):

SGCN 1A = Species of Greatest Conservation Need Tier 1A; Species for which the AGFD has entered into an agreement or has legal or other contractual obligations or warrants the protection of a closed season.

SGCN 1B = Species of Greatest Conservation Need Tier 1B; Vulnerable species.

SGCN 1C = Species of Greatest Conservation Need Tier 1C; Species for which insufficient information is available to fully assess the vulnerabilities and therefore need to be watched for signs of stress.

Bureau of Land Management (BLM):

S = Sensitive. Species that could easily become endangered or extinct in the state.

Note: Although the analysis area is a 1-mile buffer, data provided by the AGFD were for a 5-mile buffer and could not be calculated for the 1-mile buffer.

* AGFD was unable to provide data for this species so analysis was conducted based on available data about species' habitat requirements.

† Not all SGCN-listed species are addressed as part of this analysis; however, this species was added to the analysis at the request of the AGFD, a cooperating agency.

Table 3.8.4-3. Tonto National Forest vegetation type, trends, and acreages for management indicator species

Vegetation Type	Acres on Tonto National Forest	1985–2005 Vegetation Trend	Alternative 2 acres (% change)	Alternative 3 acres (% change)	Alternative 4 acres (% change)	Alternative 5 East acres (% change)	Alternative 5 West acres (% change)	Alternative 6 South acres (% change)	Alternative 6 North acres (% change)
Ponderosa pine/ Mixed conifer	283,204	Static	0 0	0 0	0 0	0 0	0 0	0 0	0 0
Pinyon/Juniper (woodland)	1,155,722	Static	16.9 0.001	16.9 0.001	58.9 0.01	37.1 0.003	20.3 0.002	44.8 0.004	42.0 0.004
Chaparral	265,480	Static	1,017.5 0.4	1,017.5 0.4	1,089.2 0.4	957.7 0.4	957.7 0.4	1,186.3 0.5	1,416.5 0.5
Desert grassland	316,894	Upward/ Static	51.2 0.02	51.2 0.02	1,372.3 0.4	51.4 0.02	47.8 0.02	69.5 0.02	69.8 0.02
Desertscrub	774,220	Downward/ Static	7,025.3 0.9	7,025.3 0.9	5,568.3 0.7	1,783.4 0.2	1,754.9 0.2	1,922.0 0.3	1,485.9 0.2
Riparian (low elevation)	41,379	No change	4.5 0.01	4.5 0.01	21.8 0.05	2.0 0.01	2.2 0.01	2.0 0.01	0.4 0.001
Aquatic	29,000	Not applicable*	14.6 0.05	14.6 0.05	14.6 0.05	14.7 0.05	14.7 0.05	14.7 0.05	14.7 0.05

Source: Data used for these calculations were a crosswalk between the Forest Service Potential Natural Vegetation metadata and the SWReGAP vegetation metadata.

* Vegetation trend not applicable, but see also analysis of aquatic trends in Devil's Canyon (Garrett 2019d), which indicates static trends in Devil's Canyon between roughly 2003 and 2017.

Impacts on Special Status Wildlife Species

ENDANGERED SPECIES ACT–LISTED WILDLIFE SPECIES

Yellow-billed Cuckoo *(Coccyzus americanus)*

The yellow-billed cuckoo, listed as threatened with proposed critical habitat for the western distinct population segment, has the potential to occur within the analysis area for all action alternatives along Devil's Canyon and Mineral Creek north of the existing Ray Mine. The species may also occur where the two Alternative 5 pipeline option routes would cross the Gila River. Proposed critical habitat for yellow-billed cuckoo is present at the proposed pipeline corridor crossings of the Gila River in the project footprint (figure 3.8.4-1).

Potential impacts on the species include a loss or modification of habitat under all action alternatives along Devil's Canyon and Mineral Creek (downstream of Devil's Canyon) north of the existing Ray Mine. These potential impacts include changes to riparian habitat from reduced surface flows due to the upstream watershed decreasing in size as well as potential reductions in inputs of groundwater from project-related pumping. Potential habitat changes include loss of riparian habitat and a conversion of habitat to a drier, xeroriparian habitat. This could cause habitat to become unsuitable for nesting by the species.

Under Alternative 5, habitat for the yellow-billed cuckoo and proposed critical habitat would be removed as needed where the proposed pipeline routes would cross the Gila River. Potential impacts on habitat and proposed critical habitat would occur on up to 17.9 acres of the 2,232.1 acres of proposed critical habitat within the analysis area. The primary constituent elements (PCEs) of the proposed critical habitat include the following (U.S. Fish and Wildlife Service 2014):

1. Primary Constituent Element 1—Riparian woodlands. Riparian woodlands with mixed willow-cottonwood vegetation, mesquite-thorn forest vegetation, or a combination of these that contain habitat for nesting and foraging in contiguous or nearly contiguous patches that are greater than 100 m (325 feet) in width and 81 hectares (200 acres) or more in extent. These habitat patches contain one or more nesting groves, which are generally willow-dominated, have above-average canopy closure (greater than 70 percent), and have a cooler, more humid environment than the surrounding riparian and upland habitats.
2. Primary Constituent Element 2—Adequate prey base. Presence of a prey base consisting of large insect fauna (for example, cicadas, caterpillars, katydids, grasshoppers, large beetles, dragonflies) and tree frogs for adults and young in breeding areas during the nesting season and in post-breeding dispersal areas.
3. Primary Constituent Element 3—Dynamic riverine processes. River systems that are dynamic and provide hydrologic processes that encourage sediment movement and deposits that allow seedling germination and promote plant growth, maintenance, health, and vigor (e.g., lower gradient streams and broad floodplains, elevated subsurface groundwater table, and perennial rivers and streams). This allows habitat to regenerate at regular intervals, leading to riparian vegetation with variously aged patches from young to old.

The proposed removal of vegetation and impacts from workers and equipment being present could lead to avoidance of the disturbed area and vicinity by the species. In addition, potential impacts on proposed critical habitat include removal of riparian woodlands, including potentially suitable nesting, foraging, and dispersal habitat and a corresponding localized reduction in the prey base for the species.

Southwestern Willow Flycatcher (*Empidonax traillii extimus*)

The southwestern willow flycatcher is listed as endangered with designated critical habitat and has the potential to occur within the analysis area where the two Alternative 5 pipeline option routes would cross the Gila River. Designated critical habitat for the species is present

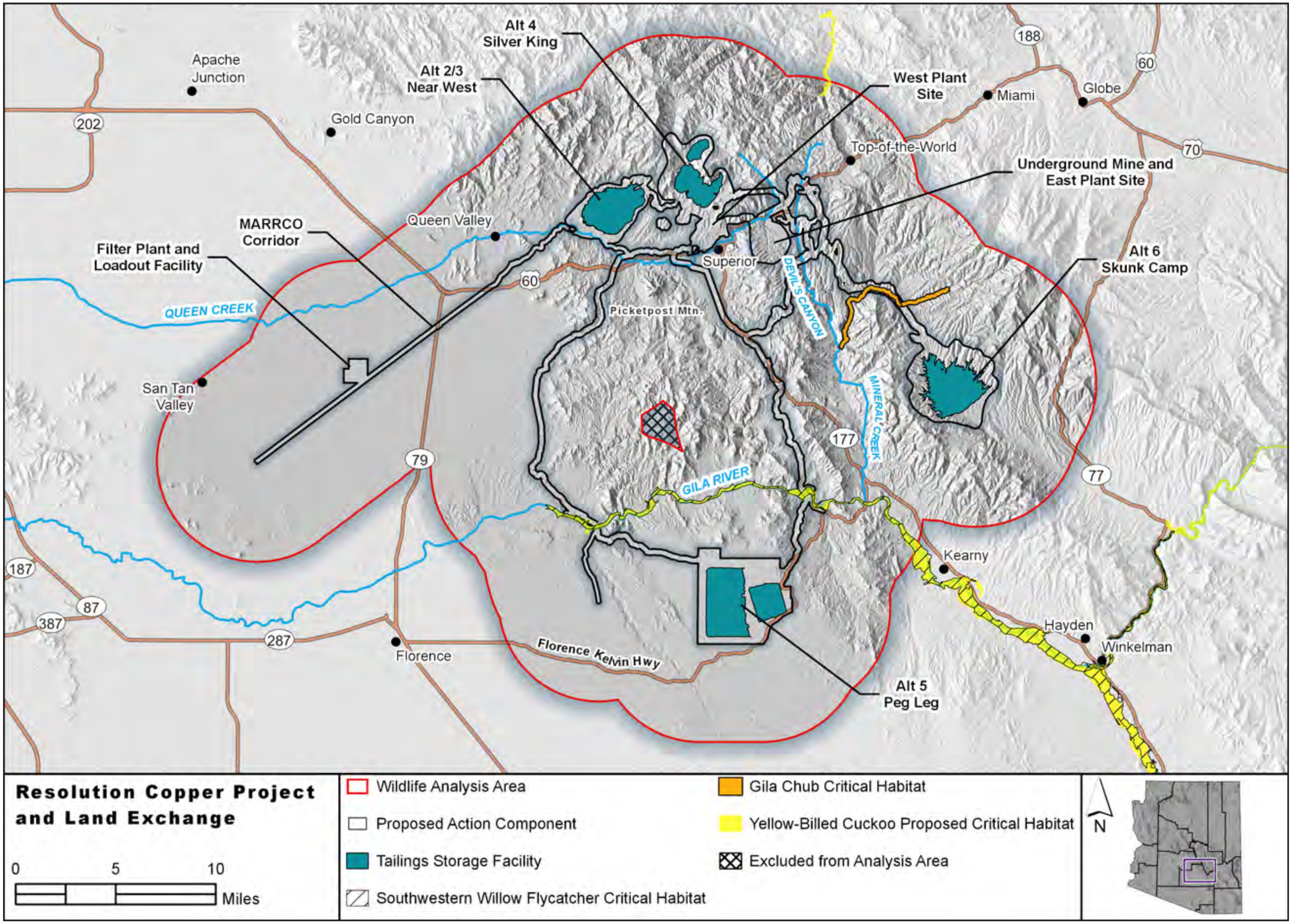


Figure 3.8.4-1. Critical habitats

at the proposed pipeline corridor crossings of the Gila River in the project footprint (see figure 3.8.4-1).

Under Alternative 5, habitat for the southwestern willow flycatcher and designated critical habitat would be removed where the proposed pipeline routes would cross the Gila River. Potential impacts on habitat and proposed critical habitat would occur on up to 12.8 acres of the 2,234.0 acres of designated critical habitat within the analysis area. The PCEs for southwestern willow flycatcher critical habitat include the following (U.S. Fish and Wildlife Service 2013):

- Primary Constituent Element 1—Riparian vegetation. Riparian habitat along a dynamic river or lakeside, in a natural or manmade successional environment (for nesting, foraging, migration, dispersal, and shelter) that comprises trees and shrubs and some combination of:
    - Dense riparian vegetation with thickets of trees and shrubs that can range in height from about 2 to 30 m (about 6–98 feet). Lower stature thickets (2–4 m or 6–13 feet tall) are found at higher elevation riparian forests, and tall-stature thickets are found at middle- and lower elevation riparian forests; and/or
    - Areas of dense riparian foliage at least from ground level up to approximately 4 m (13 feet) aboveground or dense foliage only at the shrub or tree level as a low, dense canopy; and/or
    - Sites for nesting that contain a dense (about 50–100 percent) tree or shrub (or both) canopy; and/or
    - Dense patches of riparian forests that are interspersed with small openings of open water or marsh or areas with shorter and sparser vegetation that creates a variety of habitat that is not uniformly dense. Patch size may be as small as 0.1 hectare (0.25 acre) or as large as 70 hectares (175 acres).
- Primary Constituent Element 2—Insect prey populations. A variety of insect prey populations found within or adjacent to riparian floodplains or moist environments, which can include flying ants, wasps, and bees (Hymenoptera); dragonflies (Odonata); flies (Diptera); true bugs (Hemiptera); beetles (Coleoptera); butterflies, moths, and caterpillars (Lepidoptera); and spittlebugs (Homoptera).

The proposed removal of vegetation and impacts from workers and equipment being present could lead to avoidance of the disturbed area and vicinity by the species. In addition, potential impacts on critical habitat could include removal of riparian vegetation, including potentially suitable nesting, foraging, and dispersal habitats and a corresponding localized reduction in insect prey populations used by the species.

Gila Chub *(Gila intermedia)*

Designated critical habitat for the Gila chub is found along Mineral Creek above the confluence with Devil's Canyon. The PCEs for Gila chub critical habitat include the following (U.S. Fish and Wildlife Service 2005):

- Perennial pools, areas of higher velocity between pool areas, and areas of shallow water among plants or eddies all found in small segments of headwaters, springs, or cienegas of smaller tributaries.
- Water temperatures for spawning ranging from 20 degrees Celsius (°C) to 26.5°C with sufficient dissolved oxygen, nutrients, and any other water-related characteristics needed.
- Water quality with reduced levels of contaminants or any other water quality characteristics, including excessive levels of sediments, adverse to Gila chub health.
- Food base consisting of invertebrates, filamentous (threadlike) algae, and insects.

- Sufficient cover consisting of downed logs in the water channel, submerged aquatic vegetation, submerged large tree root wads, undercut banks with sufficient overhanging vegetation, large rocks and boulders with overhangs.
- Habitat devoid of nonnative aquatic species detrimental to Gila chub or habitat in which detrimental nonnatives are kept at a level which allows Gila chub to continue to survive and reproduce. For example, the Muleshoe Preserve Gila chub and the Sabino Canyon Gila chub populations are devoid of nonnative aquatic species. The O'Donnell Canyon Gila chub population has continued to survive and reproduce despite the current level of nonnative aquatic species present.
- Streams that maintain a natural unregulated flow pattern including periodic natural flooding. An example is Sabino Canyon that has experienced major floods. If flows are modified, then the stream should retain a natural flow pattern that demonstrates an ability to support Gila chub.
- 300-foot riparian zone adjacent to each side of the stream.

The AGFD surveyed this area and found Gila chub in Mineral Creek in 2000; however, additional surveys in 2002, 2006, 2007, 2009, and 2013 found no Gila chub. Therefore, AGFD assumed the creek to be fishless in 2007 (Robinson 2007; Robinson et al. 2010). Additionally, WestLand Resources surveyed Mineral Creek in 2017 but did not find any Gila chub (WestLand Resources Inc. 2018a). As this area is not currently occupied habitat, potential impacts on surface water and groundwater would have no potential impact on the species. Potential impacts on critical habitat include reduction of perennial pools and a conversion of vegetation toward xeroriparian species; however, groundwater modeling for the action alternatives does not indicate that impacts from groundwater drawdown would significantly impact Mineral Creek in the area of designated critical habitat.

TONTO NATIONAL FOREST SENSITIVE WILDLIFE SPECIES

Potential impacts on Tonto National Forest Sensitive Wildlife Species would be as described earlier in this section in "Impacts Common to All Action Alternatives." The acres of potential impacts on modeled habitat for these species is given in table 3.8.4-2. The project-related disturbance would decrease available habitat for these species. However, given that the proposed project would impact a small portion of the overall habitat in the project vicinity for these species under all action alternatives, the proposed project may adversely impact individuals, but is not likely to result in a loss of viability in the analysis area, nor cause a trend toward federal listing of these species as threatened or endangered.

BLM SENSITIVE SPECIES

Potential impacts on BLM Sensitive Species would be as described earlier in this section in "Impacts Common to All Action Alternatives." The acres of potential impacts on modeled habitat for these species is given in table 3.8.4-2. The project-related disturbance would decrease available habitat for these species. However, given that the proposed project would impact a small portion of the overall habitat in the project vicinity for these species under all action alternatives, the proposed project may adversely impact individuals, but is not likely to result in a loss of viability in the analysis area, nor cause a trend toward federal listing of these species as threatened or endangered.

3.8.4.3 Cumulative Effects

The Tonto National Forest has identified the following list of reasonably foreseeable future actions as likely to occur in conjunction with development of the Resolution Copper Mine. The projects described below are expected, or have potential, to contribute to incremental changes in wildlife or habitat conditions near the Resolution Copper Mine. As noted in section 3.1, past and present actions are assessed as part of the affected environment; this section analyzes the effects

of any RFFAs, to be considered cumulatively along with the affected environment and Resolution Copper Project effects.

- *Pinto Valley Mine Expansion.* The Pinto Valley Mine is an existing open-pit copper and molybdenum mine located approximately 8 miles west of Miami, Arizona, in Gila County. Pinto Valley Mining Corporation is proposing to expand mining activities onto an estimated 1,011 acres of new disturbance (245 acres on Tonto National Forest land and 766 acres on private land owned by Pinto Valley Mining Corporations) and extend the life of the mine to 2039. EIS impact analysis is pending; however, this project would cause approximately 1,011 acres of existing wildlife habitat to be lost. Some portions of these areas may later be successfully reclaimed and revegetated, but other areas would remain permanently altered.
- *Ripsey Wash Tailings Project.* Mining company ASARCO is planning to construct a new tailings storage facility to support its Ray Mine operations. The environmental effects of the project were analyzed in an EIS conducted by the USACE and approved in a ROD issued in December 2018. As approved, the proposed tailings storage facility project would occupy an estimated 2,574 acres and be situated in the Ripsey Wash watershed just south of the Gila River approximately 5 miles west-northwest of Kearny, Arizona, and would contain up to approximately 750 million tons of material (tailings and embankment material). ASARCO estimates a construction period of 3 years and approximately 50 years of expansion of the footprint of the tailings storage facility as slurry tailings are added to the facility, followed by a 7- to 10-year period for reclamation and final closure. Effects on wildlife would include the direct loss of existing habitat, as well as habitat fragmentation. Impacts on threatened, endangered, and sensitive species such as southwestern willow flycatcher (endangered) and the yellow-billed cuckoo (threatened) would be expected to be indirect and minor. Cumulative effects would be most noticeable in the vicinity of Alternative 5 – Peg Leg, as both the Ripsey Wash Tailings Project and the Resolution Copper Project would remove large portions of habitat from the same general area.
- *Wildlife Water Source Improvements*. Two key projects geared toward improving wildlife access to water sources include the Government Springs Pipeline Project and the AGFD Wildlife Water Catchment Improvement Project. The Government Springs Pipeline Project would replace about 12,000 linear feet of pipeline between two existing water storage tanks and would charge the system with well water instead of an inconsistently wet spring. The stored water would be available for wildlife such as elk and deer. The AGFD water catchment project includes construction of four discrete catchments at various locations on the Tonto National Forest, with functional lifespans of about 35 years. Each catchment would include a water storage tank, a large "apron" to gather and direct precipitation to the storage tank, a drinking trough, and fencing, and would disturb no more than 0.5 acre. The AGFD catchments would be designed primarily to benefit mule deer, although they would also benefit other species such as elk, javelina, and Gambel's quail.
- *Herbicide Treatments to Control Vegetation*. There are two primary vegetation management programs proposing to use herbicides in the vicinity of Resolution Copper Mine: APS's herbicide use within their right-of-way on NFS lands, and ADOT's vegetation treatment along various road rights-of-way. APS is proposing to include Forest Service–approved herbicides as a vegetation management tool on its existing rights-of-way within five National Forests: Apache-Sitgreaves, Coconino, Kaibab, Prescott, and Tonto National Forests. If approved, the use of herbicides would become part of the APS's Integrated Vegetation Management approach. An EA with a FONSI was published in December 2018. The EA determined that environmental resource impacts would be minimal, and the use of herbicides would prevent and/or reduce fuel build-up that would otherwise result from rapid, dense regrowth

and sprouting of undesired vegetation. ADOT plans annual herbicide treatments using EPA-approved herbicides. ADOT would apply herbicides to contain, control, or eradicate noxious, invasive, and native plant species that pose safety hazards or threaten native plant communities on road easements and NFS lands up to 200 feet beyond road easement on the Tonto National Forest. Herbicide application could have short- and long-term, indirect, minor adverse impacts and short- and long-term, direct, negligible adverse impacts on the Mexican spotted owl (*Strix occidentalis lucida*), southwestern willow flycatcher, yellow-billed cuckoo, narrow-headed gartersnake (*Thamnophis rufipunctatus*), and northern Mexican gartersnake (*Thamnophis eques megalops*) and their respective habitats.

- *Bighorn Sheep Capture and Relocation*. The Tonto National Forest is intending to capture and relocate bighorn sheep over the next 3 to 5 years in order to improve forest-wide health and genetic viability of the species. The project would involve the use of helicopters and occur in five wilderness areas within the Tonto National Forest: Four Peaks, Hellsgate, Mazatzal, Salt River Canyon, and Superstition. Endangered, threatened, candidate, and proposed ESA species identified within this project area include Mexican spotted owl, Sonoran desert tortoise, bald eagle (*Haliaeetus leucocephalus*), and golden eagle (*Aquila chrysaetos*). Impacts on protected wildlife species would occur as the result of helicopter use, but effects would be minor and short-term. The overall effect on bighorn sheep would be positive, as sheep translocation would help control the population of bighorn sheep to densities less likely to succumb to communal diseases.
- *Ray Land Exchange and Proposed Plan Amendment.* ASARCO is also seeking to complete a land exchange with the BLM by which the mining company would gain title to approximately 10,976 acres of public lands and federally owned mineral estate located near ASARCO's Ray Mine in exchange for transferring to the BLM approximately 7,304 acres of private lands, primarily in northwestern Arizona. It is known that at some point ASARCO wishes to develop a copper mining operation in the "Copper Butte" area west of the Ray Mine. Under the proposed action, there would likely be total loss of existing wildlife habitat in areas where high and moderate habitat potential intersect with foreseeable mining uses. BLM sensitive species would no longer be assessed on the selected lands. BLM would acquire new potential wildlife habitat through the offered lands.
- *Tonto National Forest Travel Management Plan.* The Tonto National Forest is currently in the process of developing a Supplemental EIS to address certain court-identified deficiencies in its 2016 Final Travel Management Rule EIS. This document and its implementing decisions are expected within the next 2 years. This document will have substantial impacts on current recreational uses of NFS lands and transportation routes, which in turn would have some impact on disturbance of soils and vegetation for new road construction or decommissioning of other roads. On the Tonto National Forest as a whole, these changes should be beneficial to wildlife species, as one focus of travel management is avoidance of sensitive habitat; however, short-term disturbances would occur and potentially be cumulative with disturbances from the Resolution Copper Project.
- *Silver Bar Mining Regional Landfill and Cottonwood Canyon Road.* A private firm, Mineral Mountain LLC, is proposing to develop a landfill on land the company owns approximately 6 miles southeast of Florence Junction and 4 miles due east of SR 79. This private land lies entirely within an area of BLM-administered lands and cannot be accessed without crossing Cottonwood Canyon Road, located on BLM lands. The company received Master Facility Plan Approval for the proposed landfill from ADEQ in 2009, and a BLM right-of-way grant in 2017. The firm's proposed construction on Cottonwood Canyon Road and on the landfill property may increase the potential for introduction and/or spread of noxious weeds and invasive plants. Approximately 4 acres of creosotebush-bursage

vegetation and 11 acres of Arizona upland desertscrub would be removed to expand Cottonwood Canyon Road. Development of the landfill would result in the clearing of 350 acres of vegetation on private lands. This is some distance from Resolution Copper Project impacts, except for the Alternative 5 west pipeline option, but on a landscape scale it would contribute to loss of habitat and be cumulative with Resolution Copper Project impacts.

- *LEN Range Improvements.* This range allotment is located near Ray Mine. Under the proposed action, upland perennial sources of water would be provided to supplement the existing upland water infrastructure on the allotment. The supplemental water sources would provide adequate water facilities for existing authorized grazing management activities and would be beneficial to wildlife as well. While beneficial, these water sources are located in a different geographic area than the GDEs potentially impacted by the Resolution Copper Project.
- *Millsite Range Improvements.* This range allotment is located 20 miles east of Apache Junction, on the southern end of the Mesa Ranger District. The Mesa Ranger District is proposing to add three new 10,000-gallon storage tanks and two 600-gallon troughs to improve range condition through better livestock distribution and to provide additional wildlife waters in three pastures on the allotment. Water developments are proposed within the Cottonwood, Bear Tanks, and Hewitt pastures of the Millsite grazing allotment. These improvements would be beneficial for providing water on the landscape and are within the same geographic area where some water sources could be lost (Alternatives 2 and 3); they may offset some loss of water that would result because of the Resolution Copper Project tailings storage facility construction.

Other future projects not yet planned, such as large-scale mining, pipeline projects, power transmission line projects, and future grazing permits, are expected to occur in this area of south-central Arizona during the foreseeable future life of the Resolution Copper Mine (50–55 years). These types of unplanned projects would contribute to changes in wildlife and their respective habitats by either reducing available habitats areas, reducing habitat quality, or acting to fragment existing habitats.

3.8.4.4 Mitigation Effectiveness

The Forest Service is in the process of developing a robust mitigation plan to avoid, minimize, rectify, reduce, or compensate for resource impacts that have been identified during the process of preparing this EIS. Appendix J contains descriptions of mitigation concepts being considered and known to be effective, as of publication of the DEIS. Appendix J also contains descriptions of monitoring that would be needed to identify potential impacts and mitigation effectiveness. As noted in chapter 2 (section 2.3), the full suite of mitigation would be contained in the FEIS, required by the ROD, and ultimately included in the final GPO approved by the Forest Service. Public comment on the EIS, and in particular appendix J, will inform the final suite of mitigations.

This section contains an assessment of the effectiveness of mitigation and monitoring measures found in appendix J that are applicable to wildlife.

Mitigation Measures Applicable to Wildlife

Follow AGFD and FWS guidance for mitigation of impacts on wildlife (GP-125): Follow guidance from the AGFD and FWS regarding avoidance, minimization, and mitigation measures for wildlife. The AGFD’s Heritage Data Management System (HDMS) and Project Evaluation Program work together to provide current, reliable, objective information on Arizona’s plant and wildlife species to aid in the environmental decision-making process. The information can be used to guide preliminary decisions and assessments for the Resolution Copper Project. Similarly, the FWS provides guidance for planning for wildlife. This measure would be noted in the ROD/Final Mining Plan of Operations and would be required by the Forest Service.

Implement a wildlife management plan for stormwater ponds, including wildlife exclusion fencing (GP-131). This measure would be noted in the ROD/Final Mining Plan of Operations and would be required by the Forest Service.

Reptile and Sonoran Desert Tortoise (ESA-CCA) Plan (CA-191): Implement conservation actions detail in the Candidate Conservation Agreement. The Candidate Conservation Agreement would be a formal agreement between the FWS and Resolution Copper to address the conservation needs of proposed or candidate species, or species likely to become candidates, before they become listed as endangered or threatened. Resolution Copper would voluntarily commit to conservation actions that would help stabilize or restore the species with the goal that listing would become unnecessary. This measure would be noted in the ROD/Final Mining Plan of Operations and would be required by the Forest Service.

Mitigate for loss of abandoned mine or cave habitats for bats (CA-172): Mitigate impacts on bat habitat by conducting pre-closure surveys over multiple years and multiple visits per year, to document species presence/absence and develop appropriate closure methods in coordination with AGFD, Bat Conservation International, and Forest Service biologists; implement wildlife exclusion measures pre-closure to minimize wildlife entrapment and mortality during closure; consider seasonal timing of closure on any sites with suitable maternity roosts; and identify mines, adits, and/or shafts with known bat roosting areas. If activities are adjacent to bat roosting/maternity sites, develop best management practices to reduce human encroachment. This measure would only be applicable to Alternatives 2, 3, and 4. It would be noted in the ROD/Final Mining Plan of Operations and required by the Forest Service via 36 CFR 228.8 (Forest Service Authority to regulate mining to minimize adverse environmental impacts on NFS resources).

Maintain or replace access to stock tanks and AGFD wildlife waters (CA-175): Resolution Copper would maintain or replace access to stock tanks and AGFD wildlife waters impacted by the project. Stock tanks are used to provide drinking water for livestock. AGFD constructs wildlife water developments to support a variety of wildlife, including game species. Benefits of AGFD wildlife water developments include a long lifespan; year-round, acceptable water quality for wildlife use; require no supplemental water hauling, except in rare or exceptional circumstances; minimal visual impacts and blends in with the surrounding landscape; accessible to and used by target species and excludes undesirable/feral species to the greatest extent possible; and minimized risk of animal entrapment and mortality. This measure would be applicable to all alternatives, noted in the ROD/Final Mining Plan of Operations, and required by the Forest Service. Additional ground disturbance would not be required, as it is within the disturbance disclosed in the DEIS.

Use of best management practices during pipeline construction and operations (CA-176): Resolution Copper would adhere to best management practices during pipeline construction and operation. During pipeline construction, Resolution Copper would cover open trenching; inspect trenches routinely for entrapped wildlife and remove; provide wildlife escape ramps; inspect under construction equipment prior to use and remove any wildlife seeking cover. Resolution Copper would also include wildlife crossing structures along the pipeline corridor (overpass or underpass) and coordinate with AGFD to determine the location, frequency, and design of wildlife crossing structures. This measure would be applicable to all alternatives, noted in the ROD/Final Mining Plan of Operations, and required by the Forest Service. No additional ground disturbance is required as it is within the disturbance disclosed in the DEIS.

Mitigation Effectiveness and Impacts

Mitigation would be effective at reducing or offsetting some impacts on wildlife. Most water sources potentially impacted by the project would be replaced, impacts on cave habitat would be minimized, and impacts from ground disturbance, traffic, noise, and light would be minimized through best practices but not eliminated. However, overall a large acreage of habitat would be impacted. This loss of habitat would not be replaced in the immediate project area, though it would be offset by the exchanged lands and some mitigation proposals being developed

through the Clean Water Act permitting program (see Section 3.7.2, Surface Water Quantity).

Unavoidable Adverse Impacts

Biological resources would be impacted by direct surface disturbance, noise, vibration, light, dust, air pollutants, and traffic. Adverse impacts that cannot be avoided or completely mitigated include changes in cover, changes in foraging efficiency and success, changes in reproductive success, changes in growth rates of young, changes in predator–prey relationships, increased movement, habitat fragmentation and disruption of dispersal and migration patterns through animal movement corridors, and increased roadkill.

3.8.4.5 Other Required Disclosures

Short-Term Uses and Long-Term Productivity

Impacts on wildlife and wildlife habitat would primarily be short term and would include destruction of habitat for mine construction, disturbance from mining and associated activities, and direct mortality from increased mine-related vehicle traffic. Disturbance and direct mortality would cease at mine closure, and reclamation would eventually allow wildlife habitat to reestablish itself. However, this could take many decades or longer. Portions of the tailings storage facility landform may never return to pre-mining conditions, and the effects of reduced quality of habitat would be long term or permanent. Impacts on wildlife and aquatic habitat due to drawdown that affects streams and springs would represent a permanent loss in productivity.

Irreversible and Irretrievable Commitment of Resources

The direct loss of productivity of thousands of acres of various habitat from the project components would result in both irreversible and irretrievable commitment of the resources that these areas provide for wildlife (i.e., breeding, foraging, wintering, and roosting habitat; animal movement corridors, etc.). Some habitat could reestablish after closure, which would represent an irretrievable commitment of resources, but portions of the tailings storage facility landform may never return to pre-mining conditions, and the effects of reduced quality of habitat would likely be irreversible.

Overview

The lands around Superior, Arizona, and in particular the Oak Flat area above and directly east of the Apache Leap escarpment, have for decades been a popular recreation destination for camping, hiking, rock climbing, OHV driving, and other pursuits. Development of the project, along with pipelines, power lines, and other associated infrastructure, and a large, permanent tailings storage facility in the general vicinity of the mine, would inevitably result in the loss of some of the area's natural features and recreational opportunities. Some recreational opportunities would be permanently lost, while others would be displaced to other parts of the state. This section of the EIS is an effort to quantify, when possible, these anticipated changes.

3.9 Recreation

3.9.1 Introduction

Local, State, and Federal agencies provide opportunities for recreation throughout and adjacent to the project area. Recreation activities range from individual, casual, and dispersed use to organized, permitted events and designated recreation sites, for both motorized and nonmotorized recreation. Typical recreation in the project area includes driving for pleasure/vehicle touring, off-highway vehicle (OHV) use, hiking, rock climbing (including technical climbing and bouldering), camping, wildlife viewing and bird watching, horseback riding, mountain biking, and hunting (bird, small game, and big game).

One specific recreation concern has been the land exchange, and the subsequent loss of the Oak Flat Campground. Resolution Copper would keep the campground open as long as it is safe to do so (this is required by the NDAA), but eventually this area would be closed to public access. Another specific recreation concern is the loss of recreation opportunities and access from the large acreage of the tailings storage facility on Federal land, which for the duration of the mine operations would be closed to all non-mining uses and displace recreation to other locations.

This section discusses the general recreation setting and opportunities, special use activities, management for recreation (Forest Service, BLM, and Arizona State lands), hunting, recreation sites, and recreation opportunities specific to the project footprint, including motorized routes and rock climbing.

3.9.2 Analysis Methodology, Assumptions, and Uncertain and Unknown Information

3.9.2.1 Analysis Area

The spatial analysis area for potential direct and indirect effects on recreation resources includes the following: the East Plant Site and subsidence area, West Plant Site, MARRCO corridor, filter plant and loadout facility, tailings storage facility, transmission line corridors, pipeline corridors, the Silver King alternative (Alternative 4) and proposed pipelines and emergency slurry ponds, the Peg Leg alternative and proposed pipelines (Alternative 5), and the Skunk Camp alternative and proposed pipelines (Alternative 6). The analysis area for potential indirect and cumulative effects also extends to Management Area (MA) 2F of the Globe Ranger District of the Tonto National Forest; Passages 15, 16, 17, and 18 of the Arizona National Scenic Trail; and Game Management Units (GMUs) 24A, 24B, and 37B, as shown in figure 3.9.2-1. The temporal analysis area for direct and indirect effects is divided into three general phases: construction (mine life years 1 through 9), operations (years 6 through 45), and closure/reclamation (years 46 through 51 to 56).

3.9.2.2 Methodology

Recreation activities are interrelated and connected to other natural and social resources and resource uses. Therefore, changes to other resources (e.g., access or scenic resources) can affect recreational opportunities and use. In the following analysis we discuss actions that would alter or change the recreation settings in the analysis area or that

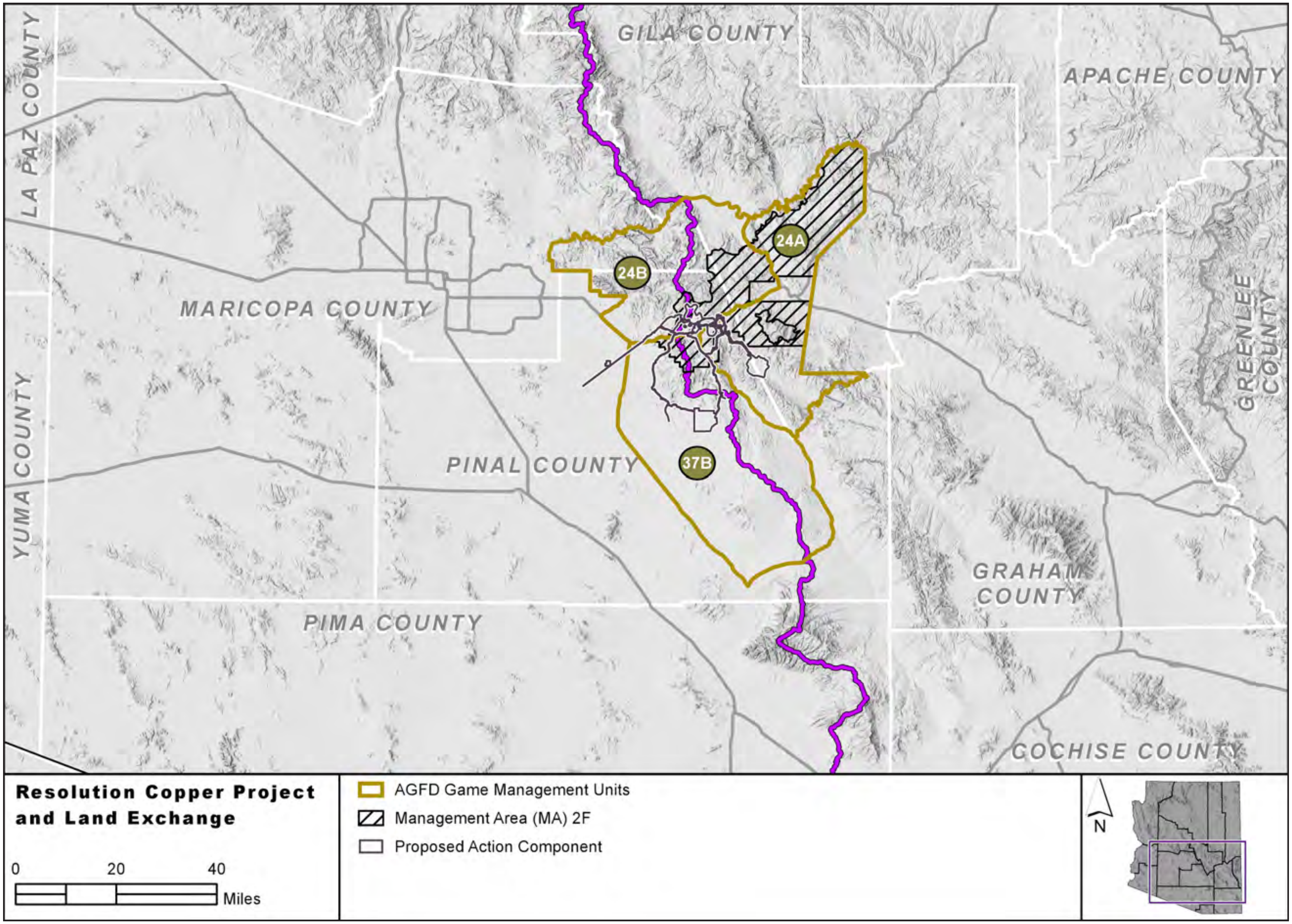


Figure 3.9.2-1. Recreation analysis area

could affect the capacity of that landscape setting to provide certain recreational opportunities. We quantify effects where possible.

Short-term impacts would primarily be associated with the construction of project infrastructure, would last as long as a particular construction activity, and would largely cease after roughly mine year 9. Long-term impacts would primarily be associated with mine operation, closure, reclamation, and post-closure, and depending on the impact, could last from mine year 9 to perpetuity.

3.9.3 Affected Environment

3.9.3.1 Relevant Laws, Regulations, Policies, and Plans

A complete listing and brief description of the legal authorities, reference documents, and agency guidance used in this recreation effects analysis may be reviewed in Newell (2018e).

Primary Legal Authorities Relevant to the Recreation Effects Analysis

- Secretarial Order 3373
- Multiple-Use Sustained-Yield Act of 1960, as amended (16 U.S.C. 528)
- Wilderness Act of 1964 (16 U.S.C. 1131–1136), as amended by the Arizona Wilderness Act of 1984
- National Trails System Act of 1968 (PL 90-543; 16 U.S.C. 1244(a)), as amended by the Arizona National Scenic Trail Act
- National Forest Management Act of 1976 (16 U.S.C. 1600)
- Tonto National Forest Land and Resource Management Plan

3.9.3.2 Existing Conditions and Ongoing Trends

General Setting

Major recreational attractions in the analysis area include the Apache Leap escarpment, Oak Flat, Picketpost Mountain, Boyce Thompson Arboretum, Arizona Trail, Queen Creek Canyon, Devil's Canyon, Hewitt Station Road, Reavis Canyon, Gila River, and Dripping Spring Mountains. A number of developed and dispersed campgrounds, day-use areas, trailheads, roads, and trails exist for both motorized and nonmotorized recreational use in the analysis area. With private funding from multiple sources, the Tonto Recreation Alliance maintains the Hewitt Station OHV trails in cooperation with the Forest Service. Dispersed and developed recreation in the analysis area is managed by the Forest Service, BLM, State of Arizona, Gila County, and Pinal County. Tonto National Forest lands (Globe Ranger District) dominate the northern portion of the analysis area, and BLM lands (Tucson Field Office) dominate the southern portion of the analysis area (figure 3.9.3-1).

NFS roads are located throughout the analysis area. Tonto National Forest is currently preparing a draft Supplemental EIS in compliance with the Final Travel Management Rule, which requires that all NFS lands designate roads, trails, and areas for motor vehicle travel. This would restrict off-road motor vehicle use and designate roads and motorized trails open to the public, in addition to designating OHV areas, big-game harvesting retrieval rules, fuelwood collection rules, and dispersed camping rules (U.S. Forest Service 2016f). NFS roads will be shown on the Tonto National Forest Motor Vehicle Use Map. The Motor Vehicle Use Map is anticipated to be released to the public once the Final Supplemental EIS is released and final ROD is signed by the Forest Supervisor.

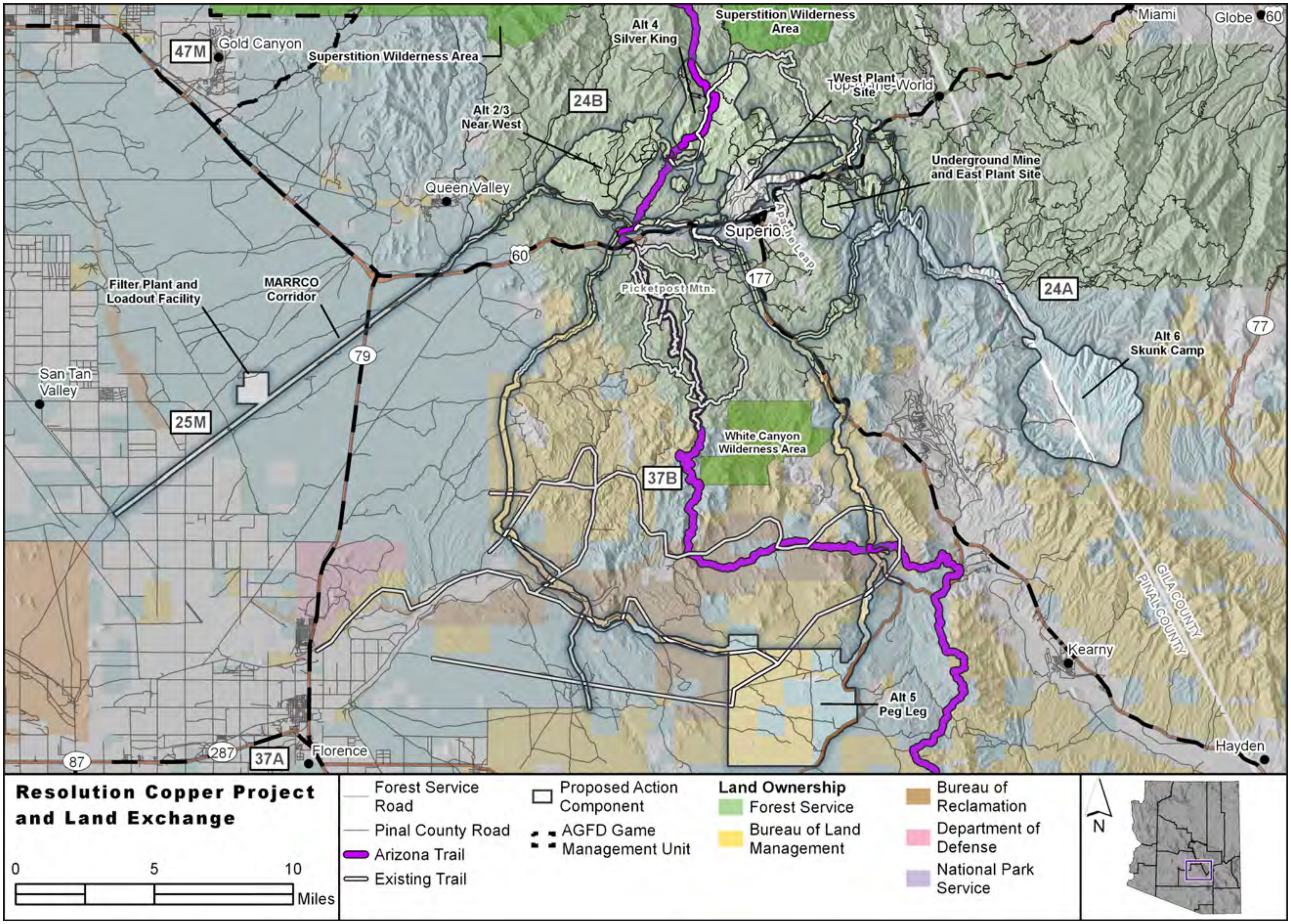


Figure 3.9.3-1. Existing recreation setting overview

The Gila-Pinal Scenic Road is a designated Scenic Byway, running along U.S. 60 from Superior to Miami, Arizona. ADOT designated the Gila-Pinal Scenic Road as a scenic road on June 20, 1986. The route travels throughout the Sonoran Desert life zone at the desert floor and moves upward through four biotic communities. Riparian woodlands are found along the many features such as Queen Creek, Arnett Creek, and Pinto Creek (America's Scenic Byways 2018).

The Legends of Superior Trails (LOST) are located along U.S. 60, providing a connection from the Arizona Trail to Superior. A portion of LOST is on lands owned by Resolution Copper. LOST is 6 miles long (with a few short side trails) and includes interpretive signage along the route (U.S. Forest Service 2013a).

Pinal County has proposed features and designations in their 2007 Open Space and Trails Master Plan, some of which would occur within the analysis area. OHV trails, trail corridors, as well as planned or proposed open space designations are intended to provide reception opportunity and connectivity throughout Pinal County. In addition, a local user group has proposed a recreation plan that coincides with part of the analysis area; this plan features new trailheads, motorized roads, motorized trails, and non-motorized trails (figure 3.9.3-2).

Special Use Activities

The Tonto National Forest manages its special use permit pursuant to 36 CFR 251, and the analysis area is used by a number of permitted recreation and commercial special use activities. Recreation events are commercial activities requiring temporary, authorized use of NFS land. Commercial activities may consist of outfitter and guide services, filming, photography, or campground management. Commercial activity on Tonto National Forest lands occurs when an entry or participation fee is charged by the applicant, and the primary purpose is the sale of a good or service. Most of these applicants offer guided tours that provide the safety, knowledge, and experience of qualified guides with quality equipment, while others provide in-demand equipment and basic instruction for visitors to explore on their own. Activities include hiking, camping, climbing, canyoneering, horseback riding, jeep tours, motorcycle riding, utility task vehicle (UTV), OHV, and ATV tours, road biking, and mountain biking. Each company follows strict operating procedures, safety practices, and Forest Service regulations to protect the environment. Additionally, group recreation events may also require a special use permit (U.S. Forest Service 2013b).

Recreation Opportunity Spectrum

The recreation setting varies on the Tonto National Forest lands throughout the analysis area, illustrated by the different recreation opportunity spectrum (ROS) classifications that occur within the analysis area: semiprimitive nonmotorized, semiprimitive motorized, roaded natural, and urban. Table 3.9.3-1 and figure 3.9.3-3 give an overview of the ROS in the analysis area.

Table 3.9.3-1. Recreation opportunity spectrum acreages

ROS Class	Acres in the Analysis Area
Semiprimitive nonmotorized	5,576
Semiprimitive motorized	21,226
Roaded natural	10,213
Urban	10,180

Note: Acreages may not total due to rounding and/or unclassified lands; acreages that are common among alternatives are not double-counted.

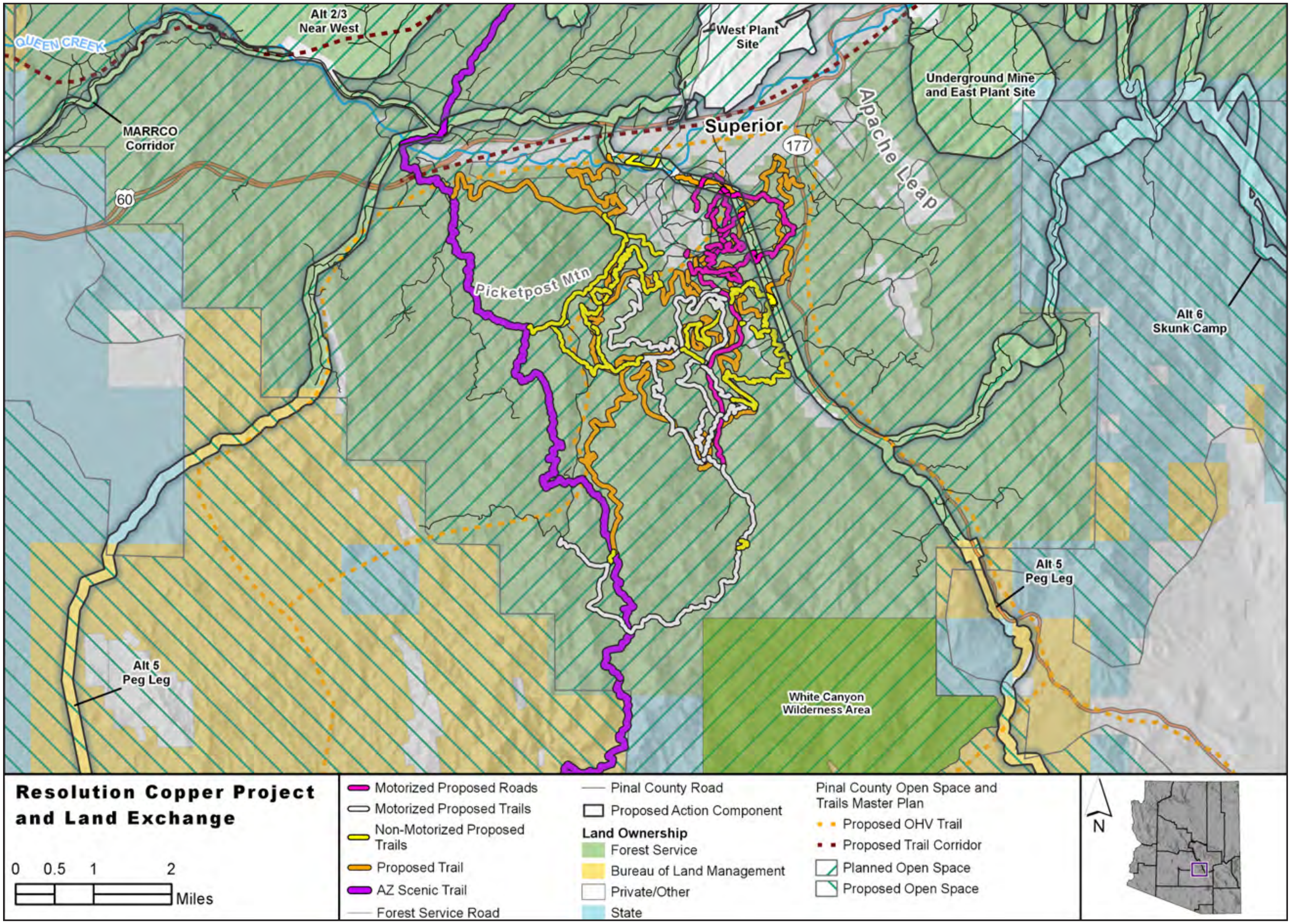


Figure 3.9.3-2. Proposed recreation setting overview

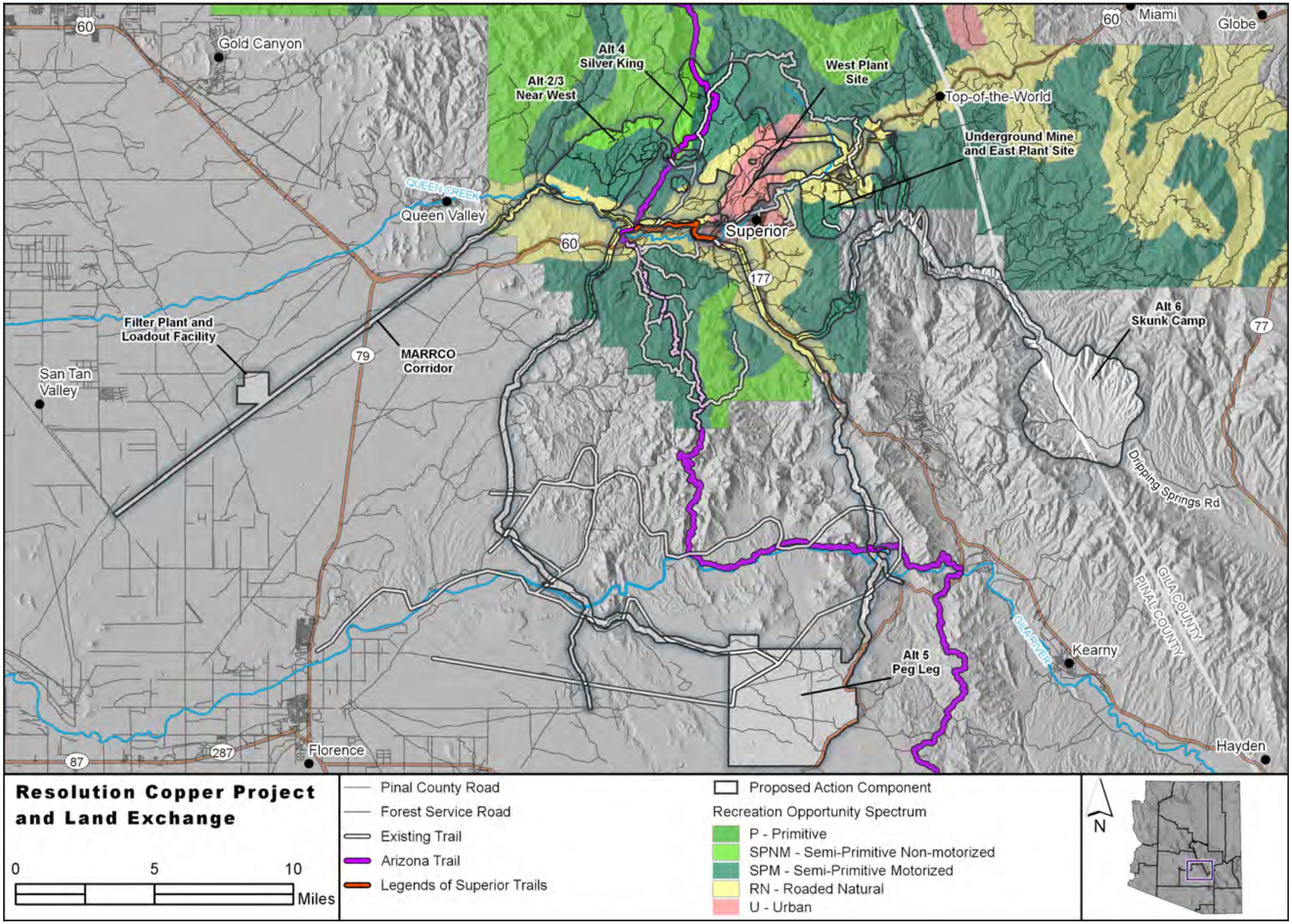


Figure 3.9.3-3. Existing recreation opportunity overview

BLM Recreation Management

The BLM currently uses an outcomes-focused recreation management framework that focuses on targeted outcomes gained from visitors engaging in recreational experiences (see BLM Handbook H-8320-1, "Planning for Recreation and Visitor Services" (Bureau of Land Management 2014)). The BLM-managed public lands provide visitors with a wide variety of outdoor recreation opportunities (activities and settings) to attain desired experiences and personal benefits. Public lands are designated as a Special Recreation Management Area (SRMA) or Extensive Recreation Management Area (ERMA). ERMAs constitute all public lands outside specially or administratively designated areas (e.g., National Land Conservation System units or ACECs, respectively), typically areas where recreation is non-specialized, dispersed, and does not require intensive management. Recreational activities are typically subject to fewer restrictions in ERMAs. There are no SRMAs in the analysis area; the nearest SRMA is the Gila River SRMA, located 10 miles to the east. All BLM-managed lands within the analysis area are managed as ERMAs.

Similar to the Forest Service, special recreation permits are another tool the BLM uses to manage recreational use of public lands. Special recreation permits are authorizations that allow for commercial, competitive, and group recreation uses of BLM-managed public lands and related waters.

BLM routes are located within the analysis area. These routes are used similar to the frequency and conditions as described for NFS routes. The BLM Tucson Field Office is currently preparing a draft travel management plan to designate roads, trails, and areas for motor vehicle travel (i.e., open, limited, or closed).

State Trust Land

Arizona State Trust land is present throughout portions of the analysis area. ASLD lands are not public lands; they are lands managed by ASLD to generate revenue for State purposes. However, recreational uses are allowed by permit and are open to hunting and fishing with a valid license. Recreation (such as hiking, camping, or motorized travel) may be allowed with a recreational permit available through the ASLD. However, some trails (such as the Arizona Trail) are available for public use without a permit.

Hunting

Hunting opportunities are available on public lands and lands managed by the ASLD within the analysis area, including AGFD GMUs 24A, 24B, and 37B (see figure 3.9.2-1). Hunted species vary greatly due to the high diversity of habitat in the analysis area, from Sonoran desertscrub to chaparral and conifer forests on the highest elevations. Commonly hunted species include but are not limited to: mule deer (*Odocoileus hemionus*), white-tailed deer (*Odocoileus virginianus*), javelina (*Pecari tajacu*), mountain lion (*Puma concolor*), black bear (*Ursus americanus*), bighorn sheep (*Ovis canadensis nelsoni*), cottontail rabbit *(Sylvilagus audubonii*), dove (*Zenaida asiatica* [white-winged]; *Streptopelia decaocto* [collared]), and Gambel's quail (*Callipepla gambelii*) (Arizona Game and Fish Department 2018b, 2018c, 2018d). Hunting primarily occurs in the fall and winter.

Hunting is permitted throughout most of the analysis area under AGFD laws and rules, established in ARS 17, Chapter 3, "Game and Fish," Article 17-309. It is unlawful for a person to discharge a firearm within 0.25 mile of an occupied farmhouse or other residence, cabin, lodge, or building without permission of the property owner or resident. Specifically, hunting is not permitted within 0.25 mile of occupied private parcels throughout the unit(s).

Recreation Sites

ARIZONA NATIONAL SCENIC TRAIL

The Arizona Trail, which is more than 800 miles long, was designated a national scenic trail in a 2009 amendment to the 1968 National Trails System Act (Arizona Trail Association 2018). The National Trails System Act of 1968, as amended, establishes national scenic trails to

provide maximum outdoor recreation potential and for the conservation and enjoyment of scenic, historic, natural, or cultural qualities of the areas which they traverse. The Arizona Trail is a primarily primitive, nonmotorized long-distance route that preserves and showcases the unique and diverse scenic, natural, historic, and cultural treasures of Arizona and our nation. The Arizona Trail experience provides opportunities for quality recreation, self-reliance, and discovery within a corridor of open space defined by the spectacular natural landscapes of the state (U.S. Forest Service 2018b).

Four trail "passages" are located within the analysis area, stretching from the Tortilla Mountains in the south to the Superstition Mountains in the north (see figure 3.9.3-1). The four passages of the Arizona Trail total approximately 84 miles of trail through the analysis area. These are Passage 15 – Tortilla Mountains; Passage 16 – Gila River Canyons; Passage 17 – Alamo Canyon; and Passage 18 – Reavis Canyon.

APACHE LEAP SPECIAL MANAGEMENT AREA

The Apache Leap SMA straddles the Apache Leap escarpment, covering 839 acres (figure 3.9.3-4; also see figure 2 of "Apache Leap Special Management Area Management Plan"), and was established in 2017 (U.S. Forest Service 2017c). The plan components form strategic direction programmatic in nature and do not authorize specific projects or activities. The plan may constrain the agency from authorizing or carrying out certain projects and activities within the SMA or dictate the manner in which they may occur. The plan would not regulate use by the public but may guide future project or activity decisions that regulate use by the public under 36 CFR Part 261 Subpart B (prohibitions in areas designated by orders). Future proposed actions within the Apache Leap SMA would be subject to the appropriate level of environmental review and analysis, public involvement, and pre-decisional administrative review procedures.

No mining activities are proposed within the SMA. However, authorized activities under the NDAA include installing seismic monitoring equipment, as well as signage and other public safety notices, and operating an underground tunnel and associated workings between the

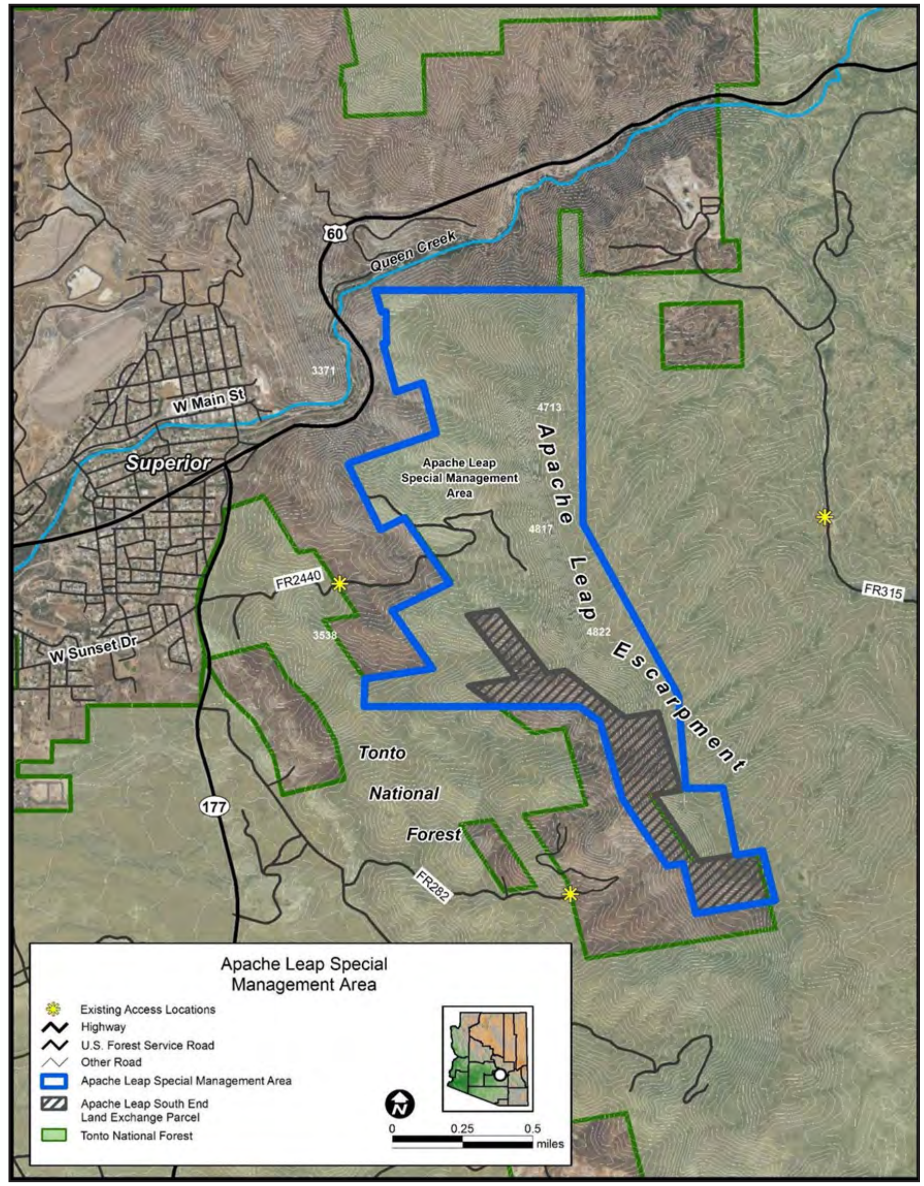


Figure 3.9.3-4. Overview of Apache Leap Special Management Area

East Plant Site and West Plant Site, which would extend beneath the Apache Leap escarpment.

OAK FLAT CAMPGROUND

The Tonto National Forest manages the Oak Flat Campground, which provides approximately 20 campsites (available first come, first served) and two vault toilets (U.S. Forest Service 2018c). The campground is situated along the Gila-Pinal Scenic Road in the rolling hills near Devil's Canyon (figure 3.9.3-5) and hosts a large stand of mature oak trees that provide natural shade. The surrounding area is known for its numerous recreational bouldering opportunities. Families and individuals like to come to this site for its natural desert beauty and rock climbing. Oak Flat Campground is also an important birding destination and considered an eBird "hotspot" with approximately 183 different species reported by birders to eBird (Arizona Game and Fish Department 2018e).

Mine Area and Associated Infrastructure

MOTORIZED ROUTES

The analysis area comprises portions of both the Mesa and Globe Ranger Districts. Generally, recreation opportunities in these areas are the same, ranging in elevation from a low point of approximately 1,500 feet along the western boundary of the analysis area (the terminus of the MARRCO corridor) up to the high point of the analysis area, King's Crown Peak (north of the East Plant Site) at approximately 5,500 feet. Commonly used NFS roads within the analysis area are described here (see also figure 3.9.3-1).

NFS Road 2440—NFS Road 2440, also known as the Cross Canyon Road, extends approximately 1.75 miles from SR 177 on the east side of Superior, Arizona, into the western portion of the Apache Leap SMA. The road is gated at its junction with private land approximately 0.5 mile from SR 177. Public users park at this gate and walk the roadbed, through the private land parcel owned by Resolution Copper, for the remaining 1.25 miles to enter the western portion of the Apache Leap SMA. From various points along this route, users leave the roadway and travel overland farther into the Apache Leap SMA for dispersed recreation opportunities.

Resolution Copper holds a permit for the use of NFS Road 2440 to access two groundwater monitoring wells (MB-03 and QC-04) within the Apache Leap SMA, as permitted by the Resolution Copper pre-feasibility plan (U.S. Forest Service 2010b). Resolution Copper conducts minimal maintenance on the road to provide the level of access necessary to collect monitoring data and maintain the wells.

NFS Road 282—NFS Road 282 extends approximately 1.75 miles from SR 177 toward the southwestern portion of the Apache Leap SMA. The road is gated at its junction with private land. Users park vehicles at this gate and access the southwestern portion of the Apache Leap SMA on undesignated user-created routes that cross private lands.

U.S. 60/Queen Creek Corridor—Users access the northern and northwestern portion of the Apache Leap SMA from several undesignated nonmotorized access routes that originate along U.S. 60 east of Superior, Arizona. Users navigate the steep slopes to climb out of the Queen Creek drainage and can also access the Apache Leap SMA to the south via undesignated trails. Access from these points requires users to cross private (owned by Resolution Copper) lands to enter the area. Scenic driving is also common along this corridor, which is designated as the Gila-Pinal Scenic Road.

NFS Road 315—NFS Road 315 is the primary access into Oak Flat and the Oak Flat Campground. Several undesignated parking areas along NFS Road 315 provide access to the eastern portion of the Apache Leap SMA. Users travel overland on multiple, nonmotorized undesignated user-created routes to the top of the Apache Leap escarpment. These routes provide the primary access for rock climbing in the Apache Leap area, as well as Lower Devil's Canyon, Hackberry Canyon, and the Refuge.

NFS Road 357/NFS Road 650 (aka Hewitt Station Road/Happy Camp Road)—NFS Road 357 and NFS Road 650 are the primary access to the Tonto National Forest lands north of Superior and south of the

Figure 3.9.3-5. Location of Oak Flat Campground

Superstition Wilderness. These routes are often combined with other nearby routes to form a loop, popular for OHV users; however, access via NFS Road 357 has been restricted by gated entry at the private property boundary. These routes also provide the primary access to the Arizona Trail, and lead to trailheads to the popular Roger's and Reavis Canyon trails.

NFS Road 342—NFS Road 342 is a popular OHV route that may also be used in conjunction with NFS Road 650 for a loop route accessed from U.S. 60 (see figure 3.9.3-1).

ROCK CLIMBING

The analysis area includes unique geological features that offer bouldering as well as technical, sport, traditional ("trad"), and top-rope rock climbing opportunities (Karabin Jr. 1996; Oliver 2017). Before 2004, the public could drive vehicles and park unimpeded along the Magma Mine Road and the area that is now the East Plant Site to access climbing areas in Oak Flat and Apache Leap. A portion of this area is now closed to public access due to safety concerns; however, limited parking is still available along the Magma Mine Road near Euro Dog Valley, the Mine Area, and Apache Leap. Resolution Copper has been working with local climbing groups since 2004 to establish legal access to their private lands that would still be available for climbing. A final agreement was signed that keeps the Pond and Atlantis climbing areas, which are on Resolution Copper–owned property, perpetually open for public use. Figure 3.9.3-6 illustrates the known climbing opportunities in the analysis area.

Oak Flat and Euro Dog Valley

The Oak Flat bouldering area is 0.5 to 1 mile southwest of Oak Flat Campground, east of Magma Mine Road (NFS Road 315) (see figure 3.9.3-6) and is managed by the Forest Service. Euro Dog Valley, Oak Flat East, and Oak Flat West all offer freestanding boulders and small cliff-lined canyons, with over 1,000 documented boulder routes and problems. The Phoenix Bouldering Contest and Phoenix Boulder Blast were held in Oak Flat from 1989 through 2004, and various other climbing and/or bouldering competitions have been held in this area as recently as 2016, including the Queen Creek Boulder Competition. These events drew competitive climbers from all over the world.

Mine Area

The Mine Area is immediately south of the East Plant Site and east (above) Apache Leap (see figure 3.9.3-6) and is on lands owned by Resolution Copper. Public access to the Mine Area has been limited since operations resumed at the former Magma Mine in the mid-2000s. Public users are not permitted beyond the security gate along Magma Mine Road. The Mine Area contains over 100 documented short sport routes (25–50 feet). Some portions of the Mine Area (nearest U.S. 60) are available to registered users.

Devil's Canyon

Northern Devil's canyon is located north of U.S. 60 (see figure 3.9.3-6). Upper Devil's Canyon is accessed from Oak Flat Campground by way of NFS Road 2438. Lower Devil's Canyon is accessed from Oak Flat Campground by way of NFS Road 315. There are over 400 documented climbing routes in Devil's Canyon, with a mixture of sport and trad routes on walls (including the 200-foot tall Nacho Wall), as well as numerous freestanding pinnacles and towers.

Apache Leap

Apache Leap contains many of the tallest climbing routes in the Queen Creek area. Climbing opportunities consist of mostly traditional routes, but also 80 bolted routes and 16 boulder problems. Popular established routes include the Lectra Area, Lost Horizon, Rim Gym, Staging Area, Punk Rock, Headstone, Citadel, The Draw, Musicland Wall, Geronimo Area, Skyscraper Area, and The Fin (Queen Creek Coalition 2015). Climbing routes in the Apache Leap area are accessed by way of Magma Mine Road (NFS Road 315). The majority of these routes are located on the escarpment (see figure 3.9.3-6) and are accessed from parking areas

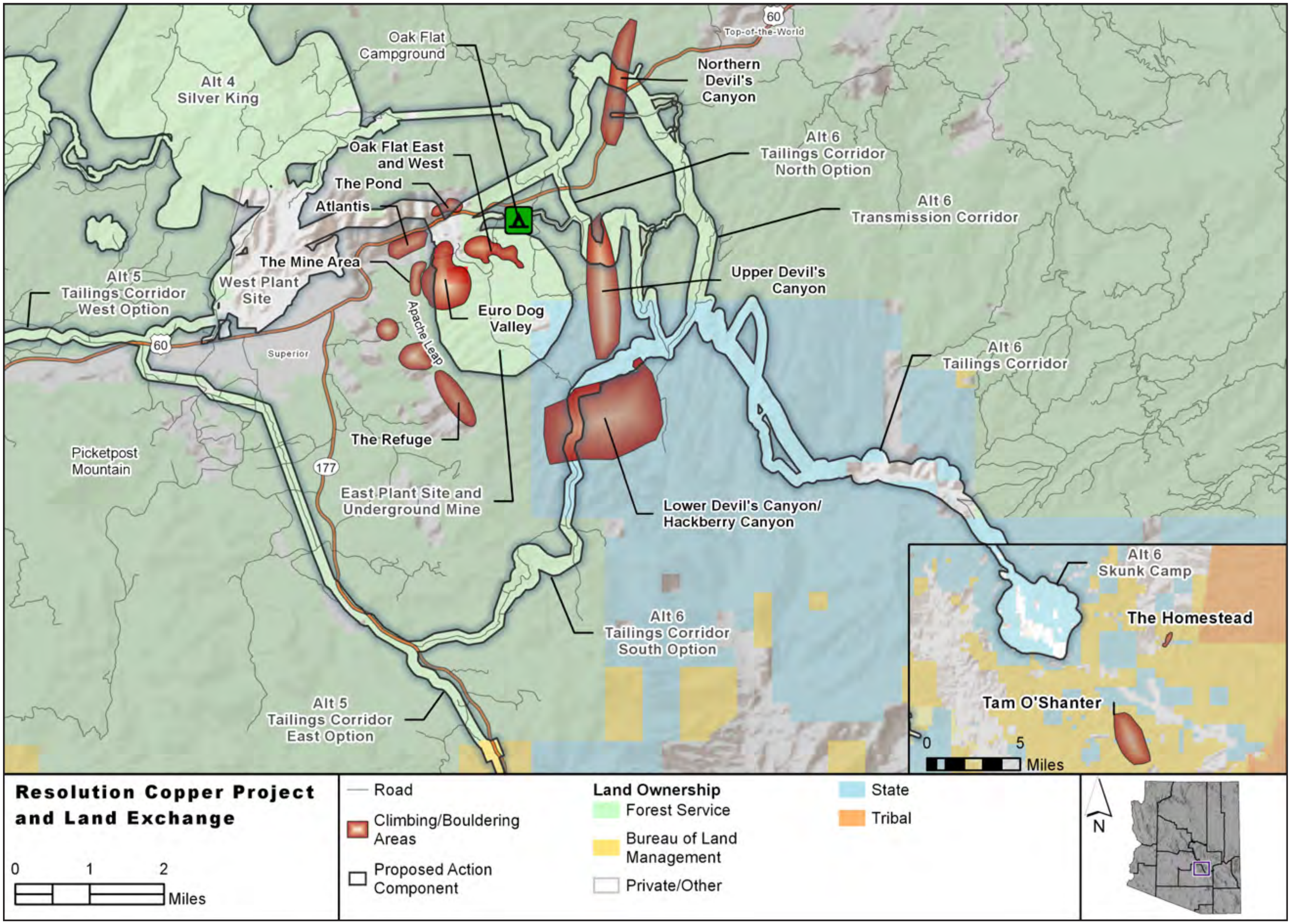


Figure 3.9.3-6. Climbing opportunities overview

on NFS Road 315. Climbers hike to the east side of the Apache Leap SMA via overland undesignated routes and rappel into the climbing areas. Other areas in the central portion of the Apache Leap SMA, including a popular route called The Fin, are accessed via NFS Road 2440 and overland undesignated routes (U.S. Forest Service 2017c).

Resolution Copper Private Land (Queen Creek Canyon)

Generally, popular sport, crack, and crag climbing routes are available along or accessed from U.S. 60 northbound from the bridge and underground tunnel, north to the top of the canyon (a stretch of approximately 2 miles). The Pond and Atlantis can be accessed from within Queen Creek Canyon, along U.S. 60 (see figure 3.9.3-6). These areas, along with the Mine Area and other climbing areas containing established climbing routes, are on Resolution Copper property and now require that users register and sign a waiver via a free, online registry to gain legal access (Resolution Copper 2018). Parking is located along U.S. 60 at various pull-offs along the highway, particularly on the north side of the tunnel.

3.9.4 Environmental Consequences of Implementation of the Proposed Mine Plan and Alternatives

Impacts that occur under more than one alternative are discussed under the first applicable alternative and are then referenced under other pertinent alternatives.

3.9.4.1 Alternative 1 – No Action

Under the no action alternative, the project would not be developed, and existing recreational uses would continue under current conditions. The settings, landscape, recreation sites, roads, and trails within the analysis area would continue to be affected by current conditions and ongoing actions. Oak Flat would remain open to public use. Routine maintenance of NFS roads, the Arizona Trail, and other recreation resources would continue.

Access to public land in the area would continue; rock climbing and bouldering opportunities in the Mine Area, Euro Dog Valley, and Oak Flat would remain available. Recreation opportunities in the analysis area would continue to be managed consistent with the ROS setting indicators and objectives of the forest plan. Hunting opportunities would not change in the analysis area. Motorized routes would not be closed as a result of any Resolution Copper mining activities, subject to existing rights and permits.

3.9.4.2 Impacts Common to All Action Alternatives

Impacts that would occur under each of the action alternatives are presented in this section. Regardless of action alternative, the principal adverse impact on recreational users of public lands as a result of the proposed action or alternatives would be through closure of lands to public access, meaning both direct loss of recreational use of the lands themselves and potential loss of access to adjacent lands because movement across these areas would become prohibited. Other impacts on recreational users may occur through increased traffic, increased noise, changes to the scenery or visual qualities of certain areas, and other mine-induced effects. Such effects are noted in the following text and addressed in greater detail in the portions of chapter 3 relevant to each of those resources.

A number of existing Resolution Copper–owned properties in the recreation analysis area are, by and large, already closed to public access: these include the privately held portions of the East Plant Site, the West Plant Site, and the filter plant and loadout facility. Thus, in the impact analyses presented in the sections that follow, loss of access to or across these private lands is not considered as a change from current, existing conditions. However, potential expansion of any of these facilities onto Tonto National Forest or other public lands as a result of project approval is considered a change from current conditions and thus an impact. So, too, is potential development of new facilities or physical alteration of lands that would result in closure of lands to recreational

use or through-access, such as construction at any of the tailings storage facility locations or development of the anticipated subsidence area at Oak Flat.

The following project components that are common to all action alternatives are considered in the impact analyses: tailings storage facility including fence line boundary; subsidence area; East Plant Site expansion onto Tonto National Forest lands; MARRCO corridor; and conveyance of the Oak Flat Federal Parcel to Resolution Copper through the NDAA-mandated land exchange. It should be noted that tailings pipelines corridors and power transmission line corridors, though part of mine facilities under any alternative, are not considered in this analysis as closed to public crossing or other access.

Components or differing configurations of components that are unique to one or more alternatives are described and addressed in the portions of the analysis specific to each alternative.

Effects of the Land Exchange

The land exchange would have significant effects on recreation. The Oak Flat Federal Parcel would leave Forest Service jurisdiction, and with it myriad recreational opportunities currently available and used by the public. The Oak Flat bouldering area offers freestanding bounders and small cliff-lined canyons with over 1,000 documented boulder routes and problems. The area has held various bouldering and climbing competitions as recently as 2016 and the Phoenix Bouldering Contests and Phoenix Boulder Blasts through 2004; all climbing and bouldering areas would be lost when the Oak Flat Federal Parcel transfers out of Federal ownership. Additional recreational activities that would be lost include camping at the Oak Flat Campground, picnicking, and nature viewing. The campground currently provides approximately 20 campsites and a large stand of native oak trees. It also is boasted as an important birding destination with approximately 183 different species reported by birders.

The offered lands parcels would enter either Forest Service or BLM jurisdiction. The eight parcels would have beneficial effects; they would become accessible by the public and would be managed by the Federal Government for multiple uses, which could include recreational activities. Some parcels, specifically Cave Creek, Tangle Creek, and Turkey Creek, all have trails leading directly into them. Under Federal management, these parcels could provide an extension of current recreational activities in those areas. Specific uses would be identified by the respective agency upon conduction of the land exchange; however, the Forest Service and BLM have the capacity to also plan for dispersed, developed, and wilderness recreation opportunities on the offered lands parcels.

Forest Plan Amendment

The Tonto National Forest Land and Resource Management Plan (1985b) provides guidance for management of lands and activities within the Tonto National Forest. It accomplishes this by establishing a mission, goals, objectives, and standards and guidelines. Missions, goals, and objectives are applicable on a forest-wide basis. Standards and guidelines are either applicable on a forest-wide basis or by specific management area.

A review of all components of the 1985 forest plan was conducted to identify the need for amendment due to the effects of the project, including both the land exchange and the proposed mine plan (Shin 2019). A number of standards and guidelines (18) were identified applicable to management of recreation resources. None of these standards and guidelines were found to require amendment to the proposed project, either on a forest-wide or management area-specific basis. For additional details on specific rationale, see Shin (2019).

While standards and guidelines were not found to require amendment, the project would have effects on the recreation resources within the Tonto National Forest by modifying the acres under ROSs. Table 3.9.4-1 lists the acres of the project footprint that would fall within each ROS category within each of the affected management areas. Also shown is the percentage this acreage represents of the total ROS category in each management area. Overall, for the semi-primitive category most likely to be affected by mining impacts (note there is no primitive acreage within

Table 3.9.4-1. Effect of the project on the recreation opportunity spectrum within Management Areas 2F and 3I (acres)

Management Area/ROS*	Alternative 2 and 3	Alternative 4	Alternative 5 (East Option)	Alternative 5 (West Option)	Alternative 6 (North Option)	Alternative 6 (South Option)
2F						
R	–	–	–	–	–	
RN	1,488 (1.5%)	1.950 (2%)	1,849 (1.9%)	1,325 (1.4%)	1,612 (1.7%)	1,926 (2%)
SPM	2,012 (<1%)	5,548 (2.4%)	986 (<1%)	1,173 (<1%)	1,665 (<1%)	1,617 (<1%)
SPNM	–	3 (<1%)	1,209 (1.8%)	–	2 (<1%)	2 (<1%)
U	1,126 (8.6%)	1,829 (14%)	–	1,153 (8.8%)	1,261 (9.6%)	1,209 (9.2%)
3I						
R	–	–	–	–	–	–
RN	727 (1.1%)	128 (<1%)	128 (<1%)	128 (<1%)	128 (<1%)	128 (<1%)
SPM	3,276 (2.6%)	–	–	–	–	–
SPNM	–	–	–	–	–	–
U	–	–	–	–	–	–

Note: Table presents acres of project footprint within each ROS, and percentage of that ROS that could be changed by the project (in parentheses)
* ROS classifications: R = roaded, RN = roaded natural, SPM = semiprimitive motorized, SPNM = semiprimitive nonmotorized, U = urban

these management areas), changes range up to 2 percent for MA 2F (non-motorized category), and up to 2.6 percent for MA 3I (motorized category). Implementation of the project would require amending the forest plan by changing the percentages of areas with semi-primitive ROS categories within management areas 2F and 3I.

Summary of Applicant-Committed Environmental Protection Measures

A number of environmental protection measures are incorporated into the design of the project that would act to reduce potential impacts on recreation. These are non-discretionary measures and their effects are accounted for in the analysis of environmental consequences.

Applicant-committed environmental protection measures by Resolution Copper include the following:

- Developing traditional and sport climbing open to the public on Resolution Copper property outside of the mining footprint through agreement with Queen Creek Coalition. Further detail can be found on the Queen Creek Coalition website and the agreement with REI.
- Developing a concentrate pipeline corridor management plan to reestablish crossing on the Arizona Trail after construction. Further detail can be found in the Concentrate Pipeline Corridor Management Plan (M3 Engineering and Technology Corporation 2019b).

To prevent exposure of the public to geological hazards, Resolution Copper would use fencing, berms, locking gates, signage, natural barriers/steep terrain (25 to 30 percent or greater), and site security measures to limit access roads and other locations near areas of heavy recreational use.

General Setting

It is possible that users could be displaced or opportunities for public recreation activities could be diminished in portions of the action alternatives area where public access is restricted. The subsidence area (approximately 1,560 acres of NFS lands, prior to the land exchange) would be lost for public access in perpetuity. Based on current knowledge, the steep and unstable slopes of the subsidence area are projected to be unsafe for future public access.

The removal of covering vegetation during pre-mining and mining operations would have an indirect impact on adjacent recreational users in the analysis area from diminishing the quality of the recreational setting. The recreation setting would be changed as a result of the visual contrast these activities introduce to the existing landscape. Although the sight of mining activities may not affect some recreational users (e.g., hunting or OHV driving), those seeking the features of a natural setting may see the change to the existing landscape as an obstacle to their chosen recreation activity.

Mining-related activities associated with each alternative (East Plant Site, subsidence area, power lines, and West Plant Site [where permitted by private landowners]) would lead to increased traffic (including large trucks) on U.S. 60 (the Gila-Pinal Scenic Road) during construction and delivery of heavy equipment. This additional activity would change the experience for some visitors driving on the scenic road, and it would affect visitor safety when visitors encounter these activities. As many as 44 round-trip truck traffic shipments would occur per day. Major deliveries requiring road shutdown would be coordinated to reduce the amount of time closures consistent with current Resolution Copper practices. However, the increase in heavy-truck traffic is expected to contribute to increased traffic noise and intermittent traffic slowdowns on this scenic portion of U.S. 60. The recreation experience for those visitors and locals who currently use U.S. 60 and the Gila-Pinal Scenic Road would change due to the increase in large truck traffic.

Special Use Activities

Existing permitted outfitter and guide services for recreation or hunting would continue to operate throughout the analysis area but would no longer be permitted to use areas within the East Plant Site (including Oak Flat), and, depending upon the alternative, the proposed tailings storage facility and tailings corridors would not be permitted in areas that are closed to public access. Future special uses would be considered on a case-by-case basis as applications are received. Special use activities are not analyzed in the following text for each alternative; supporting analysis is in the project record.

Recreation Opportunity Spectrum

A direct loss of acreage available for recreation activities would occur under all action alternatives. Each of the action alternatives would result in the direct removal of differing amounts of acres from public entry, which represents the area that would be enclosed by perimeter fencing for public safety purposes. It is assumed that all areas on NFS land (and certain ASLD, BLM, and private lands), other than that excluded for safety around the subsidence area, would eventually be opened to public access post-mining. The subsidence area (approximately 1,560 acres of NFS lands, prior to the land exchange) would be lost for public access in perpetuity. Based on current knowledge, the steep and unstable slopes of the subsidence area are projected to be unsafe for future public access. However, the exact area and timing of opening areas to public access would need to be evaluated at the end of mining activities. While not anticipated, some areas (other than the subsidence area—e.g., pipelines, rail lines, or power lines) may be not be safe for public access, while others may require public access restrictions until reclamation activities have been successfully completed.

In addition to the direct loss of acreage available for recreation activities and opportunities, a change from the existing undeveloped nature of the analysis area (semiprimitive settings) and surrounding area to a more developed, industrialized setting would occur under all action alternatives. During construction, active mining and operations, and closure and final reclamation, the affected areas would not be compatible with the established setting indicators for any of the ROS settings present.

The industrialized setting of the East Plant Site would include increased industrial noise, mine-related traffic, and equipment operation (including backup alarms). Traffic, construction, and equipment operation within the project area would result in increased noise, ranging from 80 to 30 dBA at the fence line surrounding mining operations. A noise level of 80 dBA is comparable to the sound of a forklift or front-end loader from 50 feet away. A noise level of 30 to 40 dBA is comparable to the sound of a quiet suburban area at night (Tetra Tech Inc. 2019).

Although these increased noise levels associated with operations would not be readily apparent to motorized recreational users over the sound of their personal vehicles, sounds during mine operations may be audible to campers, hikers, mountain bikers, and equestrians from the fence line surrounding mining operations or along access roads. In particular, campers using dispersed sites in close proximity to mining operations and daytime visitors to Apache Leap could be impacted by increased noise levels resulting from facility operations. However, the degree of impact from noise on dispersed recreation is largely dependent on timing, terrain shielding, open landscapes, and mining noise attenuation and dispersion.

Mining operations lighting would result in changes to the nighttime recreational setting on lands surrounding the East Plant Site by increasing sky glow and direct visible glare both from facilities and vehicles; design features would minimize the impact but would not eliminate it (Dark Sky Partners LLC 2018). These changes may contribute to displacement of dispersed, nonmotorized recreation activities and opportunities from lands within and surrounding the analysis area.

The location of the new power line corridors between Oak Flat Substation, East Plant Site, West Plant Site, and the MARRCO corridor would be the same under all action alternatives. During and following construction, the presence of a new power line would contribute to diminishing the recreation setting (classified as roaded natural) along the power line corridor but would be consistent with the management

objectives for the area. The impacts on ROS that are specific to each alternative are discussed in the following text.

Hunting

Hunting opportunities (for both big and small game) could be displaced by mining activities. This would be a minor impact on hunting overall and would not completely eliminate hunting opportunities in the affected GMUs, since the areas within GMUs that are outside of the alternatives' footprints would remain available for hunting, subject to applicable laws and regulations. Resolution Copper would post signs in accordance with the laws and regulations for hunting to indicate the areas that would be closed to hunting to accommodate mining activities. Nonetheless, impacts on individual hunters may be moderate or even major if public use of an individual hunter's preferred hunting grounds is eliminated. As shown in a recent AGFD report (Arizona Game and Fish Department 2018c), hunter valuation surveys found that a moderate to high number of hunters found the areas west of Superior, Arizona, to be of high value for hunting mule deer, white-tailed deer, javelina, quail, dove, and predator species.

In addition, human presence and mining activities would likely cause some wildlife species to temporarily avoid these areas. Many of the wildlife species being hunted would likely not be present during mining activities due to increased noise, light, and human activity. Following mining activities, disturbed areas would return to preexisting conditions to the extent practicable. It is expected that wildlife would no longer avoid areas but return to the extent that the native habitats return. Active impacts on hunting would cease and hunting opportunities would likely improve over time as wildlife habitats return to disturbed areas. Mining activities would not avoid hunting seasons in some instances and there would be site-specific, localized, moderate impact on individual hunters (or hunting groups and outfitters) during mining activities if their preferred access is temporarily or permanently closed or restricted. This impact would not extend to hunting overall, but could represent a long-term obstacle to an individual hunter's preferred access to a particular area. Coordination with the AGFD would attempt to avoid and minimize these impacts. The number of Arizona hunting permits that are issued in individual GMUs would not change as a result of any of the action alternatives being implemented. The availability to hunt in the analysis area's GMUs and the number of hunting permits per GMU would not be affected under any action alternative. Further, hunter days would not change under any alternative, since hunting could persist elsewhere in the GMU. Hunting is not analyzed for each alternative.

Recreation Sites

There would be no direct impacts on designated wilderness as a result of any of the action alternatives. Visitors to the Superstition Wilderness would have foreground and background views of the East Plant Site from trails and overlooks, which would be similar to the existing views of the East Plant Site but with a larger visual effect. The most affected views would be from the several trails that provide both motorized and nonmotorized access to mountain and ridgetop summits and would afford direct, superior (from above and oriented downward), and unadulterated views of mining operations (e.g., north of Superior or north of Oak Flat). Similarly, views from Apache Leap and Picketpost Mountain would have unadulterated views of the East Plant Site. Although the location and size of the different elements of the project vary by alternative, because of the distance and angle of views, the impacts on the public visiting the wilderness, Apache Leap, and Picketpost Mountain would be similar for all action alternatives. Views of the East Plant Site would contribute to a slightly more diminished sense of solitude and primitive setting for some wilderness visitors (see Section 3.11, Scenic Resources).

Activities from mine operations that produce sound (as described in Section 3.4, Noise and Vibration) would be noticeable to users of adjacent dispersed recreation areas. The degree of impact from noise on the recreation setting is largely dependent on the chosen recreation activity, terrain shielding, open landscapes, and mining noise dispersion.

Because recreationists would no longer have access to the lands within the areas of mining operations, it is likely that increased use would occur on other nearby lands that provide similar experiences, depending upon

the recreational user type. A minor to moderate increase in user activity would be expected to occur in recreational use areas similar to those displaced by the project elsewhere in the Globe Ranger District, as well as on other Federal, State, and County lands.

Under all alternatives, Passage 18 of the Arizona Trail, as well as several other proposed trail corridors (Logan Simpson Design Inc. 2007), would be crossed by the new slurry line that would be constructed within the MARRCO corridor. Crossing of the Arizona Trail would interfere with the nature and purposes of the Arizona Trail. Each alternative discussion presented here provides a relative degree to which each alternative interferes with the Arizona Trail. There would be short-term impacts on trail users during construction activities when disturbance precludes use for safety reasons (e.g., active grading, transport of heavy equipment, active construction), but these would only occur during the activity, and when conditions are safe for hikers, cyclists, and equestrian users, the impact would cease. Contractors would provide necessary detours or signage for Arizona Trail user awareness during these activities. The recreation setting for this portion of Passage 18 would not change. This area of Passage 18 that is intersected by the MARRCO corridor is previously disturbed, including the railroad corridor, parking lot, and Hewitt Station Road.

Motorized Recreation

Under all alternatives, certain NFS roads would be closed to public use, either because the route would be covered or removed as a result of the construction of the East Plant Site or the West Plant Site, or because the route would no longer be safe for the public to use (e.g., the subsidence area), or both. In many cases, the route is crossed by a linear feature such as the MARRCO corridor or the power line corridor and would be closed during construction, and after that time only closed for brief periods of maintenance when not safe for public use. Site-specific impacts on motorized recreation would occur but would cease when the route is safe for public use. Table 3.9.4-2 presents the NFS roads that would be impacted under all action alternatives.

Table 3.9.4-2. National Forest System roads that would be impacted under all action alternatives

NFS Road No.	Distance (miles)	Location
2432	0.78	East Plant Site/Subsidence area
2433	0.23	East Plant Site/Subsidence area
2434	0.29	East Plant Site/Subsidence area
2435	0.28	East Plant Site/Subsidence area
2438	0.32	East Plant Site/Subsidence area
315	2.28	East Plant Site/Subsidence area
3153	1.19	East Plant Site/Subsidence area
3791	0.01	East Plant Site/Subsidence area
1933	0.07	MARRCO corridor
229	0.01	MARRCO corridor
2396	0.01	MARRCO corridor
252	0.01	MARRCO corridor
293	0.01	MARRCO corridor
3454A	0.01	MARRCO corridor
3454C	0.01	MARRCO corridor
357	0.40	MARRCO corridor
8	0.01	MARRCO corridor
1010	0.37	West Plant Site
229	1.10	West Plant Site
229	1.07	Silver King Mine Road realignment
2401	0.01	Silver King Mine Road realignment

Site-specific and localized moderate impact on individual motorized users (or groups or permitted guides/outfitters) during mining activities would occur if their preferred access is temporarily or permanently closed or restricted. Indirect impacts of the loss of routes shown in table 3.9.4-2 include changes in how users must reach destinations (i.e., a change to a user's recreation experience). If closed, a given route's destination may still be reachable but from a different ingress point and potentially a sequence of connected but much longer routes. This impact would not extend to motorized recreation in the analysis area overall but could represent an obstacle or change to an individual motorized user's preferred access to a particular area.

Rock Climbing

Rock climbing opportunities at Euro Dog Valley, Oak Flat, and portions of the Mine Area would be lost under all action alternatives. Table 3.9.4-3 provides a breakdown of the climbing opportunities that would be lost under all alternatives due to the development of the East Plant Site.

The loss of Euro Dog Valley and Oak Flat would be a major, long-term impact on the climbing opportunities of central Arizona, particularly bouldering. There are no other developed climbing areas that are as specific to bouldering and that offer as numerous opportunities as Euro Dog Valley and Oak Flat in the analysis area; the nearest bouldering opportunities that even come close to the bouldering opportunities that are available at Euro Dog Valley and Oak Flat are located in northwest Phoenix (Icecapades and South Mountain); Prescott, Arizona; and Mount Lemmon near Tucson.

3.9.4.3 Alternative 2 – Near West Proposed Action

The analysis for potential impacts on recreation resources of Alternative 2 where implemented only applies to the tailings storage facility location; all other project components and activities and their potential to impact recreation resources remain identical to those described earlier in this section under "Impacts Common to All Action Alternatives."

Table 3.9.4-3. Climbing resources that would be lost under all action alternatives

Climbing Area	Roped Climbing Routes	Boulder Problems
Oak Flat (East and West)	Sport routes: 2 Trad routes: 0 Top-rope routes: 3 Aid routes: 0 **Total: 5**	Boulder problems: 527 Top-rope boulder problems: 268 **Total: 795**
Euro Dog Valley	Sport routes: 37 Trad routes: 8 Top-rope routes: 2 Aid routes: 1 **Total: 48**	Boulder problems: 179 Top-rope boulder problems: 99 **Total: 278**
The Mine Area	Sport routes: 100 Trad routes: 27 Top-rope routes: 23 Aid routes: 0 **Total: 150**	Boulder problems: 41 Top-rope boulder problems: 0 **Total: 41**

Source: Oliver (2017)

General Setting

The tailings storage facility would be located in an area of the Tonto National Forest that experiences high use (particularly during the fall and winter seasons) for both dispersed and motorized recreation. All public access would be eliminated on approximately 7,788 acres, the area to be fenced surrounding the tailings storage facility and tailings corridor, the borrow area, the East Plant Site, land exchange boundary, and subsidence area. Though the analysis area has a long history of mining, the current recreation setting would change in the tailings storage facility and immediately adjacent lands. Activities involving hiking or driving to ridgetops increase the likelihood that the tailings storage facility would be visible and change the recreation setting. The Arizona Trail is approximately 1 mile east of the tailings storage facility, paralleling the eastern boundary of the tailings storage facility for 3 miles. Dispersed

recreation activities would be temporarily affected as noises, visual disturbances, and/or the presence of other humans could detract from their chosen recreation opportunities and activities. Recreation users who seek opportunities for solitude commonly seek areas where they would be less likely to see other humans.

The changes to public motorized access could permanently change the OHV use patterns in the area, subject to Federal, State, and local OHV and traffic laws and regulations. New private access roads would be signed and would be closed to the public, but illegal OHV use may not be entirely preventable on the new access roads. Existing and new OHV users may be drawn to the tailings storage facility and tailings corridor through curiosity and interest in mining. Design features such as locked gates and signage indicating road status would decrease the magnitude of these impacts. Illegal and/or unauthorized use of access roads would be enforceable by Forest Service law enforcement, or other local jurisdiction law enforcement (e.g., County or State).

Recreation Opportunity Spectrum

The Alternative 2 tailings storage facility, borrow area, and tailings pipeline corridor would result in the direct removal of up to approximately 4,994 acres of Tonto National Forest lands from public entry, which represents the area that would be enclosed by perimeter fencing for public safety purposes. Access to lands within the perimeter fence would be closed to the public for safety concerns from perimeter fence construction through closure and final reclamation.

None of the tailings storage facility would occur within the semiprimitive nonmotorized setting. Approximately 4,239 acres of the tailings storage facility would be within the semiprimitive motorized setting, and approximately 664 acres within the roaded natural setting; these areas would be unavailable for public use. Figure 3.9.3-3 shows the ROS settings that would be impacted by all action alternatives. The ground disturbance and installation of facilities associated with the tailings storage facility and tailings corridor would result in a change from the existing undeveloped, semiprimitive nonmotorized and motorized recreation setting on lands surrounding the tailings storage facility to a developed setting, visible from superior views for miles in all directions. People currently use these areas for a wide variety of recreation activities. This change would result in a reduction of approximately 13 percent of the available semiprimitive nonmotorized setting, 17 percent of the available semiprimitive motorized setting, and 5 percent of the available roaded natural setting within the Globe Ranger District. While most of these lands would still be available for these uses after closure of the mine, the recreation opportunity available to the public would change. For instance, once deemed safe, reclaimed tailings facilities could become opened to non-motorized or motorized recreation. The proposed borrow area would also be closed to the public, representing a loss of approximately 90 acres of semiprimitive motorized areas.

The activities proposed under Alternative 2 would represent a change to the existing recreational setting; however, it is anticipated that changes would be consistent with the designated ROS classification of semiprimitive motorized.

Recreation Sites

Visitors to the Superstition Wilderness, Picketpost Mountain, and Apache Leap would have foreground and background views of the Alternative 2 facilities from trails and overlooks, and the recreation setting from certain site-specific views would change if the tailings storage facility were visible. The tailings storage facility would be located 3.75 miles from the Superstition Wilderness, 3 miles from Picketpost Mountain, and 5.25 miles from Apache Leap.

In the Passage 18 segment, 0.07 mile of the proposed tailings pipeline corridor would intersect the Arizona Trail, interfering with the nature and purpose of Passage 18 of the Arizona Trail. The intersection of the Arizona Trail occurs in two separate locations, approximately 4 miles north of the beginning (i.e., trailhead) of Passage 18, and approximately 14 miles south of the ending of Passage 18, where the Arizona Trail transitions to another passage at the southern boundary of the Superstition Wilderness.

The area of these intersections is in highly variable topography. At the point of intersections with Alternative 2, the Arizona Trail is located on the bottom of drainages associated with Potts and Whitford Canyons, flanked by steep canyon walls on all sides in an area that is relatively undisturbed, but does show signs of motorized uses and mining activities, such as traffic on NFS Road 982. NFS Road 982 shares the same point of intersection with the proposed Alternative 2 tailings corridor as the Arizona Trail. This area is currently managed under the ROS classification of semiprimitive motorized.

Because Alternative 2 would result in substantial interference with the nature and purpose of the Arizona Trail, Resolution Copper is proposing substantial design features. Resolution Copper would construct an "overpass" for the tailings corridor that would span the Arizona Trail, as shown on Figure 3.0-1h of the GPO. Recreation access along Passage 18 would be maintained during construction, and the span would not impede Arizona Trail access during operation or maintenance. There would be short-term impacts on trail users during construction activities when disturbance precludes use for safety reasons (e.g., active grading, transport of heavy equipment, active construction), but these would only occur during the activity, and when conditions are safe for hikers, cyclists, and equestrian users, the impact would cease. Contractors would provide necessary detours or signage for Arizona Trail user awareness during these activities. Because the area is managed by the Tonto National Forest as semiprimitive motorized, the activities proposed under Alternative 2, while representative of a change to the recreation setting, would not change the setting in a manner that would change the recreation setting of Passage 18.

Motorized Recreation

The tailings storage facility would intersect 27 NFS roads. Appendix K of the GPO provides a breakdown of the NFS roads that would be impacted by Alternative 2. Not all NFS roads impacted by project activities would be rerouted. However, where motorized access along connecting roads would be interrupted by the tailings storage facility, roads would be rerouted to maintain connectivity across the landscape. More detail can be found in Section 3.5, Transportation and Access.

Rock Climbing

There are no known or documented climbing resources within the proposed Alternative 2 tailings storage facility or along the tailings corridor; opportunities to develop new climbing resources would not be available. This tailings facility location would not have additional impacts on climbing resources outside of the impacts common to all.

3.9.4.4 Alternative 3 – Near West Ultrathickened

The impacts would be the same as described under Alternative 2.

3.9.4.5 Alternative 4 – Silver King

General Setting

The recreation setting is similar to that described under Alternative 2. The area currently experiences slightly less use than Alternative 2 and 3 because access (both nonmotorized and motorized) requires traveling farther distances or more difficult routes than Alternatives 2 and 3.

Recreation Opportunity Spectrum

A total of approximately 3 acres of tailings storage facility, fence line, and tailings pipeline corridor would be within semiprimitive nonmotorized settings, approximately 4,654 acres within the semiprimitive motorized setting, and approximately 528 acres within the roaded natural setting; these areas would be unavailable for public use. In addition, approximately 566 acres of urban areas (or unclassified areas) would be unavailable for public use. Figure 3.9.3-3 shows the ROS settings that would be impacted by all action alternatives. The ground disturbance and installation of facilities associated with the tailings storage facility and tailings corridor would result in a change from the existing undeveloped, semiprimitive nonmotorized and

motorized recreation setting on lands surrounding the tailings storage facility to a developed setting, visible from superior views for miles in all directions. People currently use these areas for a wide variety of recreation activities. This change would result in a reduction of approximately 17 percent of the available semiprimitive nonmotorized setting, 16 percent of the available semiprimitive motorized setting, and 7 percent of the available roaded natural setting within the Globe Ranger District. While most of these lands would still be available for these uses after closure of the mine, the recreation opportunity available to the public would change. After mine closure and reclamation, it is anticipated that the ROS value of semiprimitive nonmotorized would be restored to the Silver King area to the extent practical. The proposed borrow area would also be closed to the public, representing a loss of approximately 90 acres of semiprimitive motorized areas.

The activities proposed under Alternative 4 would represent a change to the existing recreational setting; however, it is anticipated that changes would be consistent with the designated ROS classification of semiprimitive motorized.

Recreation Sites

Visitors to the Superstition Wilderness, Picketpost Mountain, and Apache Leap would have foreground and background views of the tailings storage facility from trails and overlooks, and the recreation setting from certain site-specific views would change if the tailings storage facility were visible. The tailings storage facility would be located approximately 0.6 mile from the southern boundary of the Superstition Wilderness, 4 miles from Picketpost Mountain, and 1.95 miles from the north end of Apache Leap.

The Arizona Trail is located within the Alternative 4 proposed tailings storage facility. This would result in substantial interference to the nature and purpose of the Arizona Trail. Implementation of Alternative 4 would require 3.05 miles of the Arizona Trail to be closed and relocated to an area that would be safe for public use, which would meet the intent of the National Trails System Act and fulfill the nature and purpose of the Arizona Trail. Relocation of the Arizona Trail would require identification, environmental studies, and construction to replace the approximately 4 to 5 miles of existing trail that would be impacted under Alternative 4. The new construction would require a different trailway approach and exit in addition to the 3.05-mile direct loss of Arizona Trail. A temporary route may be required for Arizona Trail through-hikers for approximately 1 to 2 years until a permanent reroute location is identified, studied, and designated. In addition to the Arizona Trail, the Silver King alternative also intersects multiple other proposed NFS trail corridors.

Motorized Recreation

The tailings storage facility would intersect 26 NFS roads. Not all NFS roads impacted by this alternative would be rerouted. However, where motorized access along connecting roads would be interrupted by the tailings storage facility, roads would be rerouted to maintain connectivity across the landscape. More detail can be found in Section 3.5, Transportation and Access.

Rock Climbing

There are no known or documented climbing resources within the Alternative 4 tailings storage facility or along the tailings corridor; opportunities to develop new climbing resources would not be available. This tailings facility location would not have additional impacts on climbing resources outside of the impacts common to all.

3.9.4.6 Alternative 5 – Peg Leg

General Setting

The majority of the tailings storage facility and tailings corridor for this alternative would be located on BLM-administered lands that experience low to moderate dispersed recreation. Recreation is generally concentrated on lands adjacent to the Gila River, north of where the tailings storage facility would be located. BLM-administered lands within and adjacent to the tailings storage facility are managed as an

ERMA, where typically recreation is non-specialized, dispersed, and does not require intensive management. All public access would be eliminated on 10,781 acres (6,484 acres of which is BLM-administered and open to public recreation), the area to be fenced surrounding the tailings storage facility. The remaining 4,267 acres located within the fenced area of the tailings storage facility are private and Arizona State Trust lands. The Arizona Trail is located approximately 2 miles east of the tailings storage facility, roughly paralleling the eastern boundary of the tailings storage facility for approximately 4 miles. Recreational users that seek opportunities for solitude commonly seek areas where they would be less likely to see other humans. Dispersed recreation activities would be temporarily affected as noises, visual disturbances, and/or the presence of other humans could detract from their chosen recreation opportunities and activities during the approximately 50-year mine life.

Only 7.7 miles of the east pipeline corridor and 8.8 miles of the west pipeline corridor would be located on Tonto National Forest land south of the town of Superior, where they pass east and west of Picketpost Mountain and Boyce Thompson Arboretum. This area of the Tonto National Forest experiences high-use dispersed and motorized recreation and nonmotorized use on the LOST trails. The main segment of the LOST trails would be crossed by the west pipeline corridor and would include impacts similar to those described under Alternative 2 for the Arizona Trail. Impacts on recreation on Tonto National Forest lands and OHV use patterns on public lands would be similar to those described for Alternative 2.

Recreation Opportunity Spectrum

Only some portions of this alternative are located on Tonto National Forest land; therefore, only the acres of ROS that could be impacted by the tailings storage facility pipeline corridor rights-of-way described above are quantitively discussed in this section. Impacts on recreation on BLM-administered and State Trust lands are described under “General Setting.”

None of the tailings storage facility would be within the identified ROS settings, and only portions of the tailings corridor would be within the identified ROS settings. The west tailings corridor option would include 210 acres of roaded natural, 189 acres of semi-primitive motorized, and 32 acres of urban; while the east tailings corridor option would include 434 acres of roaded natural, 2 acres of semi-primitive motorized, and 88 acres of urban. Figure 3.9.3-3 shows the ROS settings that would be impacted by all action alternatives. The ground disturbance and installation of facilities associated with the tailings storage facility pipeline corridors would result in a change from the existing undeveloped recreation setting on lands surrounding the tailings storage facility pipeline corridor right-of-way to a more developed setting. People currently use these areas for a wide variety of recreation activities. The activities proposed under Alternative 5 pipeline routes would represent a change to the existing recreational setting; however, it is anticipated that changes would be consistent with the designated ROS classification of semiprimitive motorized.

Recreation Sites

Visitors to the White Canyon Wilderness would have background views of the tailings storage facility east pipeline corridor from some trails and overlooks, and the recreation setting from certain site-specific views would change if the tailings storage facility east pipeline corridor were visible. The White Canyon Wilderness is located approximately 0.6 mile from the tailings storage facility east pipeline corridor at its nearest point.

The Arizona Trail is within the Alternative 5 proposed tailings storage facility east (for approximately 0.13 mile) and west (for approximately 0.18 mile) pipeline corridor rights-of-way; the portion of the Arizona Trail Passage 18 intersected by the west pipeline corridor right-of-way is located within the MARRCO corridor and impacts would be the same as those discussed in “Impacts Common to All Action Alternatives.” Impacts on the Arizona Trail Passage 16 (Gila River Canyons) as a result of the intersection with the east pipeline corridor are discussed in more detail in the following text.

The Arizona Trail would be intersected by 0.18 mile of the proposed tailings storage facility east pipeline corridor, in the Passage 16 segment. The intersection with the Arizona Trail is approximately 20 miles south

of the beginning (i.e., trailhead at the Tonto National Forest boundary) of Passage 16, and approximately 6 miles north of the ending of Passage 16, where the Arizona Trail transitions to another passage when it crosses the Kelvin–Riverside Bridge.

The area of this intersection is in the uplands adjacent to the Gila River on BLM-administered land, with sweeping views of the Gila River Canyon and mountains to the south. At the point of intersection with the Alternative 5 tailings storage facility east pipeline corridor, the Arizona Trail is located on the southern flank of uplands north of the Gila River floodplain and just southeast of The Spine, a prominent geological feature. The area is largely undisturbed; with the exception of the Southern Pacific rail line located on the south side of the Gila River; there is very little to no motorized access to the area.

Because Alternative 5 would result in substantial interference with the nature and purpose of the Arizona Trail, Resolution Copper is proposing substantial design features. Resolution Copper would construct an “overpass” for the tailings corridors that would span the Arizona Trail, as shown on Figure 3.0-1h of the GPO. Recreation access along Passage 16 would be maintained during construction, and the span would not impede Arizona Trail access during operation or maintenance. There would be short-term impacts on trail users during construction activities when disturbance precludes use for safety reasons (e.g., active grading, transport of heavy equipment, active construction), but these would only occur during the activity, and when conditions are safe for hikers, cyclists, and equestrian users, the impact would cease. Contractors would provide necessary detours or signage for Arizona Trail user awareness during these activities. The Peg Leg alternative also intersects several proposed Pinal County trail corridors and OHV trails, as well as one planned OHV trail (Logan Simpson Design Inc. 2007).

Both the east and west tailings pipeline corridors would be visible from trails and overlooks on Picketpost Mountain. Resolution Copper anticipates burying the pipelines through these areas.

The BLM manages the area as Visual Resource Management Class III (see Section 3.11, Scenic Resources, for a detailed discussion of BLM Visual Resource Management classes) which allows for a moderate amount of visual change to the landscape, to which the activities proposed under Alternative 5 would conform. The presence of the tailings storage facility east pipeline corridor in the area would result in long-term impacts on the undisturbed and natural character of the landscape, resulting in a change to the recreation setting of that portion of Passage 16. The west pipeline corridor would be located partially within the previously disturbed MARRCO corridor. Therefore, it would have a reduced effect on recreation relative to the east pipeline corridor option, which is largely undisturbed.

Motorized Recreation

The tailings storage facility west pipeline corridor right-of-way would intersect 14 NFS roads and the tailings storage facility east pipeline corridor right-of-way would intersect 18 NFS roads. The tailings storage facility would intersect three named roads (Tea Cup Road, Tea Cup Ranch Road, Peg Leg Road) and an unknown number of unnamed roads and trails. There would be approximately 23 miles of BLM routes that would be intersected by the tailing storage facility. Not all NFS and BLM roads impacted by this alternative would be rerouted. However, where motorized access along connecting roads would be interrupted by the tailings storage facility, roads would be rerouted to maintain connectivity across the landscape. More detail can be found in Section 3.5, Transportation and Access.

Rock Climbing

There are no known or documented climbing resources within the tailings storage facility or tailings corridors.

3.9.4.7 Alternative 6 – Skunk Camp

General Setting

The majority of the tailings storage facility for this alternative would be located on Arizona State Trust and private lands that experience low levels of public dispersed recreation. The tailings corridor crosses Forest

Service, Arizona State Trust and private lands with low levels of public dispersed recreation. The area shows evidence of OHV recreation, and numerous unnamed jeep trails are present throughout valley bottoms and along ridges; however, the majority of the area is undisturbed. BLM-administered lands adjacent to the tailings storage facility are managed as an ERMA, where typically recreation is non-specialized, dispersed, and does not require intensive management. All public access would be eliminated on 8,647 acres, the area to be fenced surrounding the tailings storage facility, of which 2,132 acres is private and 6,515 acres is State Trust land.

Recreation users that seek opportunities for solitude commonly seek areas where they would be less likely to see other humans. Dispersed recreation activities would be temporarily affected as noises, visual disturbances, and/or the presence of other humans could detract from their chosen recreation opportunities and activities.

Only 7.7 miles of the north pipeline corridor and 10.8 miles of the south pipeline corridor would be located on Tonto National Forest land adjacent to the town of Superior, where the south pipeline corridor passes south of Superior and east of Picketpost Mountain and Boyce Thompson Arboretum and the north pipeline corridor passes east of Oak Flat. The main segment of the LOST trails would be crossed by the south pipeline corridor and would include impacts similar to those described under Alternative 2 for the Arizona Trail. The north pipeline corridor also crosses multiple sections of Devil's Canyon. These areas of the Tonto National Forest experiences high-use dispersed and motorized recreation.

Recreation Opportunity Spectrum

Similar to Alternative 5, only some portions of this alternative are located on Tonto National Forest land (none of the tailings storage facility would be located on areas of ROS classifications). Impacts on recreation on BLM-administered and State Trust lands are described under "General Setting."

Figure 3.9.3-3 shows the ROS settings that would be impacted by all action alternatives. The ground disturbance and installation of facilities associated with the tailings storage facility, tailings corridor, and new powerline would result in a change from the existing undeveloped, recreation setting on lands surrounding the tailings storage facility to a developed setting. People currently use these areas for a wide variety of recreation activities. The activities proposed under Alternative 5 pipeline routes would represent a change to the existing recreational setting; however, it is anticipated that changes would be consistent with the designated ROS classification of semiprimitive motorized.

Recreation Sites

No designated recreation sites or scenic trails are located within the tailings storage facility or tailings corridors, nor would the tailings storage facility be visible from any designated wilderness areas. However, the portions of this alternative in Pinal County are designated Open Space suitable for recreation purposes (Logan Simpson Design Inc. 2007). The southern tailings pipeline corridor would be visible from trails and overlooks on Picketpost Mountain, and the northern tailings pipeline corridor would be visible from the Superstition Wilderness.

Motorized Recreation

The tailings storage facility north pipeline corridor right-of-way would intersect 23 NFS roads, the tailings storage facility south pipeline corridor right-of-way would intersect 24 NFS roads, and the transmission line corridor right-of-way would intersect four NFS roads.

The tailings storage facility would intersect three named roads (Dripping Springs Road, Troy Ranch Road, and Looney Springs Trail) and an unknown number of unnamed roads and trails within the Dripping Springs basin. There would be approximately 15 miles of BLM routes that would be intersected by the tailing storage facility. Not all NFS and BLM roads impacted by this alternative would be rerouted. However, where motorized access along connecting roads would be interrupted by the tailings storage facility, roads would be rerouted to maintain

connectivity across the landscape. More detail can be found in Section 3.5, Transportation and Access.

Rock Climbing

There are no known or documented climbing resources within the fence line of the Alternative 6 tailings storage facility; however, the tailings storage facility pipeline corridors and power line corridor for Alternative 6 cross three areas of high-quality climbing resources. The north pipeline corridor crosses Upper Devil's Canyon, the south pipeline corridor crosses Lower Devil's Canyon, and the tailings storage facility power line corridor crosses Northern Devil's Canyon. There would be short-term impacts on recreators during construction activities when disturbance precludes use for safety reasons (e.g., active grading, transport of heavy equipment, active construction), but this would only occur during the project-related activity, and when conditions are safe for climbing, the impact would cease. The presence of the tailings storage facility pipeline corridors and transmission line infrastructure across the canyons may block or eliminate climbing routes, as well as change the dispersed recreation setting of the areas. Under this alternative, there would be temporary impacts on climbing resource access in the area.

3.9.4.8 Cumulative Effects

The Tonto National Forest has identified the following reasonably foreseeable future actions as likely, in conjunction with development of the Resolution Copper Mine, to contribute to cumulative changes to recreational opportunities and use patterns in the greater vicinity of the town of Superior and the "Copper Triangle" region. As noted in section 3.1, past and present actions are assessed as part of the affected environment; this section analyzes the effects of any RFFAs, to be considered cumulatively along with the affected environment and Resolution Copper Project effects.

- *Pinto Valley Mine Expansion.* The Pinto Valley Mine is an existing open-pit copper and molybdenum mine located approximately 8 miles west of Miami, Arizona, in Gila County. Pinto Valley Mining Corporation is proposing to expand mining activities onto an estimated 1,011 acres of new disturbance (245 acres on Tonto National Forest land and 766 acres on private land owned by Pinto Valley Mining Corporation) and extend the life of the mine to 2039. Although the Tonto National Forest is still evaluating the potential environmental effects of this proposed action, it is assumed that additional mine-related haul traffic along U.S. 60 between Top-of-the-World and the Miami–Globe area may conflict with recreational users traveling to or through this part of the Tonto National Forest.
- *Ripsey Wash Tailings Project*. ASARCO is planning to construct a new tailings storage facility to support its Ray Mine operations. The environmental effects of the project were analyzed in an EIS conducted by the USACE and approved in a ROD issued in December 2018. As approved, the proposed tailings storage facility project would occupy an estimated 2,574 acres and be situated in the Ripsey Wash watershed just south of the Gila River approximately 5 miles west-northwest of Kearny. The Ripsey Wash area has been a popular area, in particular, for mountain biking and OHV enthusiasts. With construction of the tailings storage facility, recreational use of this area south of the Gila River would be lost and most likely displaced to other locations. In addition, construction of the Ripsey Wash tailings storage facility would require relocation of an existing portion of the Arizona Trail farther to the east, with about 6.4 miles of new trail construction primarily along the eastern slopes of the Tortilla Mountains and about 0.2 miles of shared use along Riverside Drive. Cumulative impacts with the Resolution Copper Project are primarily related to the disruption of recreation opportunities associated with Alternative 5 – Peg Leg, which would impact some of the same general recreation lands south of the Gila River.
- *Ray Land Exchange and Proposed Plan Amendment.* ASARCO is also seeking to complete a land exchange with the BLM by which the mining company would gain title to approximately 10,976 acres of public lands and federally owned mineral estate

located near ASARCO's Ray Mine in exchange for transferring to the BLM approximately 7,304 acres of private lands, primarily in northwestern Arizona. It is known that at some point ASARCO wishes to develop a mining operation in the scenic "Copper Butte" area west of the Ray Mine. The Copper Butte area, which lies just to the east and adjacent to the BLM-managed White Canyon Wilderness, has long been a popular location for hikers, rock climbers, horseback riders, OHV treks, and camping. It is unclear at this time how mining development would adversely affect recreational use of this area, but there would likely be an effect, which would likely be a reduction in recreational opportunities.

- *Central Arizona Project (CAP) Trail Plan*. The U.S. Bureau of Reclamation and Pinal County, in coordination with Maricopa County, are planning to develop a continuous, non-motorized, 10- to 20-foot-wide recreation corridor along the length of the CAP canal in Pinal County; this system would tie in to the Maricopa County Regional Trail System. This project would create additional recreational opportunities along the CAP canal in both counties.
- *Tonto National Forest Plan Amendment and Travel Management Plan*. The Tonto National Forest is currently in the process of revising its Forest Plan to replace the plan now in effect, which was implemented in 1985. Simultaneously, the Tonto National Forest is developing a Supplemental EIS to address certain court-identified deficiencies in its 2016 Final Travel Management Rule EIS. Both documents and their respective implementing decisions are expected within the next 2 years. Both documents will have substantial impacts on current recreational uses of NFS lands. The Supplemental EIS proposes a total of 3,708 miles of motorized routes open to the public, a reduction from the 4,959 miles of motorized open routes prior to the Travel Management Rule. Limiting availability of motorized routes open to the public would result in reduced access to recreational activities currently practiced on the Tonto National Forest, including sightseeing, camping, hiking, hunting, fishing, recreational riding, and collecting fuelwood and other forest products.
- *Bighorn Sheep Capture and Relocation*. The Tonto National Forest is intending to capture and relocate bighorn sheep over the next 3 to 5 years in order to improve forest-wide health and genetic viability of the species. The project would involve use of helicopters, including in five wilderness areas within the Tonto National Forest (Four Peaks, Hellsgate, Mazatzal, Salt River Canyon, and Superstition). It is expected that improvements in bighorn sheep numbers would benefit many types of recreational users of NFS lands.
- *Copper King Exploratory Drilling/Superior West Exploration*. This project combines the environmental review of two mineral exploration projects proposed by Bronco Creek Exploration, Copper King, and Superior West. While Bronco Creek Exploration is the mining claimant, the exploration would be funded and bonded by Kennecott Exploration Company (part of the Rio Tinto Group), which would be the operator of record for both plans of operations. The combined projects result in a total of 106 unique drill site locations identified, of which the proponent would be authorized to select up to 43 to be drilled over a 10-year period. Existing roads and helicopters would be used to access drill sites. The use of helicopters could interfere with recreational opportunities for recreationists seeking solitude and a natural setting; however, these impacts would be temporary and short lived and would be unlikely to cumulatively add to Resolution Copper Project impacts.
- *ADOT Vegetation Treatment*. ADOT plans to conduct annual treatments using EPA-approved herbicides to contain, control, or eradicate noxious, invasive, and native plant species that pose safety hazards or threaten native plant communities on road easements and NFS lands up to 200 feet beyond road easement on the Tonto National Forest. It can be reasonably assumed that ADOT would continue to conduct vegetation treatments along U.S. 60 on the Tonto National Forest during the expected

life of the Resolution Copper Mine (50–55 years) for safety reasons. The vegetation treatment could impact motorized use along roads from additional traffic and road use, but impacts would be minimal and would be unlikely to cumulatively add to Resolution Copper Project impacts.

- *Silver Bar Mining Regional Landfill and Cottonwood Canyon Road*. A private firm, Mineral Mountain LLC, is proposing to develop a landfill on land the company owns approximately 6 miles southeast of Florence Junction and 4 miles due east of SR 79. This private land lies entirely within an area of BLM-administered lands and cannot be accessed without crossing Cottonwood Canyon Road, located on BLM lands. The company received Master Facility Plan Approval for the proposed landfill from ADEQ in 2009 and a BLM right-of-way grant in 2017. This project would improve and maintain road conditions on Cottonwood Canyon Road for landfill haul truck traffic. As a result, the road would be made more reliable for use by road and street vehicles used by recreational visitors. The proposed action would result in the loss of recreation parking areas on BLM land. A new parking area for the public is proposed on the landfill property, but does not appear to be sufficient for current recreational users. As a result, recreational users are likely to lead to resource damage by creating new turnouts or enlarging existing turnouts on BLM land east of the Sandman Road intersection. Recreational access would be temporarily impacted along Cottonwood Canyon Road during construction. Recreational users would be detoured and would be likely to impact existing parking areas along Mineral Mountain Road.
- *Wild and Scenic River Eligibility.* Segments of Arnett Creek and Telegraph Canyon were evaluated for their eligibility for inclusion in the National Wild and Scenic Rivers System in October 2017 as part of the forest plan revision process. These river segments were identified as eligible for inclusion because they possess unique and outstandingly remarkable values for both scenery and fisheries. The eligible river segments of Arnett Creek and Telegraph Canyon will be managed to protect their outstandingly remarkable values (scenery and fisheries) and to retain their classification as Recreational until such time as they are formally designated, or because of changed circumstances, no longer meet wild and scenic river eligibility criteria. Eligibility status and public recognition of the outstandingly remarkable values may attract additional recreational use of the river segments or adjoining national forest area, potentially cumulative with displaced recreation caused by Resolution Copper Project impacts.
- *Recreation Special Use Permits.* The Tonto National Forest manages their recreation special use permits pursuant to 36 CFR 251, and the analysis area is used by a number of permitted recreation and commercial special use activities. Recreation events are commercial activities requiring temporary, authorized use of NFS land. Commercial activity on Tonto National Forest lands occurs when an entry or participation fee is charged by the applicant, and the primary purpose is the sale of a good or service. Most of these applicants offer guided tours that provide the safety, knowledge, and experience of qualified guides with quality equipment, while others provide in-demand equipment and basic instruction for visitors to explore on their own. Activities include hiking, camping, climbing, canyoneering, horseback riding, jeep tours, motorcycle riding, UTV and ATV tours, road biking, and mountain biking. Each company follows strict operating procedures, safety practices, and Forest Service regulations to protect the environment. Special use permits are likely to positively contribute toward recreational activities and access. These are cumulative with Resolution Copper Project impacts on recreation and access, which are overall adverse, from displacement of recreation and loss of roads. Some mitigation activities undertaken by Resolution Copper would offset some of these losses, and may be beneficial to special use permit holders, providing greater opportunities and access.

Recreational uses on the Tonto National Forest, BLM-administered public lands, Arizona State Trust lands, and private lands in this part of south-central Arizona will no doubt continue to evolve during the foreseeable future life of the Resolution Copper Mine (50–55 years). Some changes in recreational use may be driven by issuance of new Federal and State land management policies and planning decisions, whereas others may develop more organically through shifting population distribution, newly emerging patterns of tourism or other visitation, or by evolving technology. For example, OHV use on public lands was not a popular pursuit several decades ago, and conflicts or potential conflicts between motorized and non-motorized forms of recreation was not a prominent issue; today, however, this issue is an ongoing concern to land-management agencies responsible for ensuring both public access and resource protection.

3.9.4.9 Mitigation Effectiveness

The Forest Service is in the process of developing a robust mitigation plan to avoid, minimize, rectify, reduce, or compensate for resource impacts that have been identified during the process of preparing this EIS. Appendix J contains descriptions of mitigation concepts being considered and known to be effective, as of publication of the DEIS. Appendix J also contains descriptions of monitoring that would be needed to identify potential impacts and mitigation effectiveness. As noted in chapter 2 (section 2.3), the full suite of mitigation would be contained in the FEIS, required by the ROD, and ultimately included in the final GPO approved by the Forest Service. Public comment on the EIS, and in particular appendix J, will inform the final suite of mitigations.

This section contains an assessment of the effectiveness of design features from the GPO and mitigation and monitoring measures found in appendix J that are applicable to recreation resources.

Mitigation Measures Applicable to Recreation

Relocation of Arizona National Scenic Trail (RC-212): Resolution Copper has proposed to fund the relocation of a segment of the Arizona Trail as well as the construction of new trailheads. Approximately 9 miles of new trail would need to be built between U.S. 60 and NFS Road 650 near Whitford Canyon . Resolution Copper proposed this measure and seeks to mitigate impacts on recreational opportunities on the trail. This measure is only applicable to Alternatives 2, 3, and 4. Relocating the trail and constructing new trailheads would require additional ground disturbance but the exact area of new disturbance has yet to be determined, although it is assumed the new trail would be about 2 to 3 feet in width and totaling approximately 3 acres in area. If any of the applicable alternatives are selected, this measure would be required by the Forest Service and would be noted in the ROD/Final Mining Plan of Operations.

Mitigate loss of bouldering at Oak Flat by establishing access to the "Inconceivables" (RC-213): To mitigate impacts on recreation through the loss of bouldering areas at Oak Flat, Resolution Copper has proposed to establish access to an alternative area known as "Inconceivables." This area extends along cliffs for approximately 3 miles on Tonto National Forest land and is located off SR 177. This mitigation measure is applicable to all alternatives. It would be required by the Forest Service and noted in the ROD/Final Mining Plan of Operations. Additional ground disturbance is required, but the exact area has not been identified at this time.

Implement Recreation User Group and Superior Trail Network Plan (RC-214): Resolution Copper has proposed to implement the Recreation User Group (RUG) and the Superior Trail Network Plan to offset loss of public roads at Oak Flat. The RUG was formed to develop a recreational trail design in the town of Superior area. The RUG has developed a conceptual plan for a trail system on the Tonto National Forest that would meet the needs and interests of different stakeholders as well as the management priorities of the Tonto National Forest. Within the vicinity of Superior, there is a network of unpaved roads and trails, many of which are not authorized by the Tonto National

Forest, that are contributing to ongoing resource degradation. The development of a trail system would help with reducing continued development of unauthorized trails. The purposes of the RUG and Superior Trail Network Plan are to provide recreation opportunities for hikers, equestrians, mountain bicyclists, and OHV enthusiasts; provide readily accessible recreation opportunities to the Superior and Phoenix metropolitan areas; offer long-term, sustainable economic benefits to the local community through recreation and ecotourism; protect soil resources in the area from erosion; and provide access to uniquely beautiful viewsheds within Tonto National Forest that are not currently accessible by authorized trails. The full plan, if implemented, would require 66.5 acres of additional ground disturbance and would be applicable to all alternatives. It would be required by the Forest Service and noted in the ROD/Final Mining Plan of Operations.

Provide replacement campground (RC-215): Resolution Copper has proposed to establish an alternative campground site, known as Castleberry, to mitigate the loss of Oak Flat Campground. The development of the new campground as well as access to the property would require additional ground disturbance of 41 acres. This measure is applicable to all alternatives and would be required by the Forest Service and noted in the ROD/Final Mining Plan of Operations.

Develop access to Oak Flat Campground while safe per MSHA regulations (RC-216): To mitigate the future permanent loss of Oak Flat Campground, Resolution Copper has proposed to develop an access plan for the campground as long as it is safe per MSHA regulations. This would allow access to Oak Flat Campground after the land exchange has occurred and the parcel is privately owned by Resolution Copper. The exact duration and extent of access would be determined later per safety requirements by MSHA. This measure would mitigate both losses to recreation as well as impacts on tribal values, would be applicable to all alternatives, and would require no additional ground disturbance. The measure would be noted in the ROD/Final Mining Plan of Operations and would be required by the Forest Service.

Arizona Trail construction considerations (GP-230): To effectively mitigate interference with through-hikers and riders who are doing the entire Arizona Trail in one trip, work that shuts down the trail should be done when use on that section is least likely to occur, which is June through August.

Burying the pipeline on either side of the Arizona Trail overpass and naturalizing the overpass and pipeline corridor in scenic areas within 0.5 mile of the trail would help to avoid substantial interference with the nature and purposes of the trail.

Mitigation Effectiveness and Impacts

The RUG plan would provide effective mitigations for the loss of motorized recreation opportunities and would improve access conditions in the immediate area with the development of three new trailheads. Other mitigations would be effective at partially replacing climbing and camping opportunities, though not in the same location or with the same characteristics.

Impacts for all the mitigations could result in roughly an additional 110 acres of ground disturbance.

Unavoidable Adverse Impacts

Recreational use of the area would be permanently adversely impacted. Unavoidable adverse impacts on recreation include long-term displacement from the project area; and the loss of public access roads throughout the project area. These impacts cannot be avoided or fully mitigated.

3.9.4.10 Other Required Disclosures

Short-Term Uses and Long-Term Productivity

Recreation would be impacted in both the short and long term. Public access would be restricted within the perimeter fence until mine closure, which is considered to be a short-term impact. However, much or all of the tailings and subsidence area may not be available for uses such

as OHV or other recreational use in the future, depending on the final stability and revegetation of these areas.

Irreversible and Irretrievable Commitment of Resources

In general, there would be irretrievable and irreversible impacts as a result of displaced recreational users and adverse effects on recreation experiences and activities. There would be irretrievable impacts on recreation with all action alternatives. Alternatives 2, 3, and 5 with the west corridor option would cross the Arizona Trail. Alternative 4 would require rerouting of the trail.

Each action alternative would result in the permanent removal of off-highway routes, resulting in a permanent loss of recreation opportunities and activities. Public access would only be permitted outside the mine perimeter fence. Although routes through the project area might be reestablished after closure of the East Plant Site, West Plant Site, filter plant and loadout facility, and the MARRCO corridor, routes through the subsidence area and tailings storage facility likely would not be reestablished. Therefore, impacts on OHV routes are considered irretrievable for those that would be reestablished following mine closure, and irreversible for those that would be permanently affected.

Even after full reclamation is complete, the post-mine topography of the project area may limit the recreation value and potential for future recreation opportunities.

Overview

Among the primary concerns expressed by the public during the scoping period for the Resolution Copper Mine EIS were the potential risks posed by mine operations to public health and well-being. These included the potential for toxic air emissions, contamination of groundwater and surface water, tailings storage facility failure, increased risk of wildfire, and increased potential for accidental spills or releases of hazardous chemicals or other pollutants. This section addresses, in three parts, tailings facility and pipeline safety, fire risks, and the potential for releases or public exposure to hazardous materials. Air emissions issues are analyzed in Section 3.6, Air Quality, and the potential for mine-related contamination of water sources is assessed in Section 3.7.2, Groundwater and Surface Water Quality.

3.10 Public Health and Safety

3.10.1 Tailings and Pipeline Safety

3.10.1.1 Introduction

During scoping, the public expressed concern for the potential failure of a tailings embankment as well as the potential for failure of the copper concentrate and tailings pipelines. Some commenters cited recent high-profile tailings facility failures in Brazil and British Columbia as examples of the possible consequences.

Tailings storage facilities represent a long-term source of risk to public health and safety that extends well beyond the operational life of the mine. Catastrophic failures are one type of risk. In these cases, the tailings embankment can fail either because of a design or foundation flaw, a failure in construction, errors in operation, natural phenomena like earthquakes or floods, and often combinations of these factors. While the tailings themselves are solid particles, the material stored behind the embankment is a mixture of tailings solids and water. With a catastrophic failure of a tailings embankment, the tailings material stored in the facility behaves like a liquid. Massive amounts of tailings materials can spill from the facility and flow downstream for long distances, even hundreds of miles.[58]

A tailings embankment failure is similar to other high-consequence, low-probability events, such as catastrophic wildfires, hazardous material spills, or 1,000-year floods. The likelihood of these events happening is low and given their nature it is not possible to predict when or how they might occur. However, they do occur, and when they occur the impacts can be severe.

Bowker (2019) cataloged 254 failures of tailings facilities worldwide occurring between 1915 and 2019, with 121 categorized as serious or very serious,[59] and at least 46 events resulting in loss of life. In the recent past, since 2000, Bowker documents the occurrence of 32 serious or very serious failure events, of which 18 resulted in loss of life.[60] More than 100 of the failures between 1915 and 2019 were in the United States, with about a quarter of them serious or very serious; the last serious failure in the United States was in Kentucky in 2017, which also resulted in loss of life. Bowker also documents a number of known tailings failures in the vicinity of the project, including Pinto Valley (1997, classified as a serious failure), Ray Mine (four failures between 1972 and 2011, including one classified as serious in 1993), and Magma Mine itself (1991, classified as a minor failure).

A tailings embankment failure has immediate consequences to those in the vicinity and

58. Note that this refers primarily to slurry tailings facilities (like Alternatives 2, 3, 5, and 6). Alternative 4 is a filtered tailings facility and would likely react differently during a failure; this difference is described in this section.

59. The researchers based this designation on loss of life, high release volume (more than 100,000 cubic meters), or long travel distance.

60. Concerning recent high-profile events, the dataset includes the Mount Polley (British Columbia, 2014) and Fundão (Brazil, 2015) failures, as well the much-publicized failure of the tailings facility in Brumadinho, Brazil, in January 2019.

living downstream, including loss of life, destruction of property and infrastructure, and destruction of entire ecosystems (aquatic or terrestrial). Once the tailings stop moving downstream, long-term consequences from a catastrophic failure continue through the contamination of large geographic areas, compromised water supplies, economic disruption, and displacement of large numbers of people.

Aside from catastrophic failures, tailings storage facilities can represent other long-term risks to public health and safety, including the potential for groundwater contamination from tailings seepage, erosion of material into downstream waters, and windblown dust. While tailings facilities gradually drain over time, becoming less susceptible to failure, the potential risks can last for many decades after closure. One study identified that roughly 80 percent of tailings facility failures occur in active facilities and 20 percent occur at closed facilities (Strachan and Van 2018).

The concentrate and tailings pipelines are also potentially susceptible to failure. Failures can occur from pipe damage due to geotechnical hazards such as rockslides or ground subsidence, from hydrologic hazards such as scour or erosion, seismic hazards, human interference, or even lightning. Failures of these types of pipelines are not generally tracked, because the consequences of tailings pipeline failures are substantially less severe than a tailings embankment failure. The petroleum industry is the only source of published information on the frequency of pipeline failures. Natural gas or petroleum pipelines run at much higher pressures than those planned for the tailings and concentrate pipelines and the contents are more immediately hazardous (flammable), but they still represent a useful estimate of the type and frequency of pipeline failures.

For the petroleum industry, the frequency of failures in the United States has been estimated as 16 gas or petroleum pipeline failures per year, out of roughly 500,000 miles of pipeline (Porter et al. 2016). This can be looked at in other ways as well. The research translates to roughly 0.03 failures per year per 1,000 miles of pipeline (Porter et al. 2016) for a 30-mile tailings pipeline, the risk of failure in any given year would be about 0.1 percent. Other research has found that the failure rate is substantially lower for large-diameter pipelines and decreases with the amount of soil cover (European Gas Pipeline Incident Data Group 2015). This research also indicates that the most common failure types are pinhole leaks and holes, and the least common failure type is a complete rupture of the pipeline (European Gas Pipeline Incident Data Group 2015).

Besides the potential magnitude of a release, pipeline failures are substantially different from embankment failures. Pipelines are monitored with pressure sensors and can shut down immediately upon a rupture being detected, leading to relatively localized releases that can likely be readily cleaned up. Pipeline risk also decreases to zero after closure, unlike the tailings embankment which can still represent a risk decades after closure.

The tailings and pipeline safety analysis in the DEIS addresses three public safety and natural resource protection commitments of the Forest Service:

1. To disclose risks and the potential magnitude and type of downstream impacts from a hypothetical tailings embankment failure;
2. To disclose risks and potential impacts associated with a failure of the tailings or copper concentrate pipelines; and
3. To ensure that the design of any tailings storage facility built on Federal land meets all expectations for safety, including a minimum requirement to adhere to National Dam Safety Program guidelines.

3.10.1.2 Analysis Methodology, Assumptions, and Uncertain and Unknown Information

Analysis Area

The analysis area for tailings and pipeline safety consists of all downstream areas that could be affected in the event of a partial or complete failure of the tailings embankment, as shown in figure

3.10.1-1, including human and natural environments, as well as the water bodies that could be impacted by a pipeline rupture or spill.

Analysis Techniques

A number of approaches are available to assess the risk of failure of a tailings storage facility, as well as the downstream effects of a failure. These techniques can be used to inform the decision process and to help analyze the potential differences between alternatives.

There are two basic steps frequently used to understand the potential size and extent of a failure.

- First, a risk-based design approach can be used to assess the inherent risks in a given design. One common tool is a failure modes and effects analysis (FMEA). The purpose of conducting a risk-based design process is to identify potential ways an embankment could fail (modes), the type of failure (whether the tailings act as a fluid or a solid), and also to develop design and operational strategies to mitigate the risk.
- Second, in the event a failure were to occur, a breach analysis (also known as a runout analysis or inundation analysis) can be used to assess the potential downstream impacts of where the tailings would travel, how far, and how fast.

The Forest Service is using both of these steps in the NEPA process. For the DEIS, the Forest Service is using a worst-case assumption that a full breach would occur and that the tailings would act like a fluid as they ran out, with resulting catastrophic impacts. This type of analysis does not consider controls or design features that would be employed to prevent this type of failure or limit potential damage; these features are identified and discussed in “Summary of Applicant-Committed Environmental Protection Measures” in section 3.10.1.4. For the DEIS, a failure modes analysis has been conducted using the DEIS designs for each of the tailings storage facility alternatives. A breach analysis has also been conducted using a simple empirical technique based on a database of past failures. For more discussion of techniques evaluated by the Forest Service, see Newell and Garrett (2018c).

FAILURE MODES AND EFFECTS ANALYSIS

When tailings facilities fail, they fail for specific reasons, or often a combination of reasons related to design (design flaws, design oversights like unknown foundation conditions, or deviation from planned design), operations (improper pond management or tailings deposition practices), and environmental triggers (seismic events, extreme precipitation). In general, these are known as “failure modes.” There is no such thing as a “typical” facility failure, as each situation is the result of a specific failure mode or combination of failure modes.

An industry-standard step in the design of a tailings facility is to conduct an FMEA:

> Failure modes and effects analysis (FMEA) is a technique that considers the various fault (or failure) modes of a given element and determines their effects on other components and on the global system. It is an iterative, descriptive and qualitative analytical methodology that promotes, based on the available knowledge and information, the systematic and logical reasoning as a means to improve significantly the comprehension of the risk sources and the justification for the decisions regarding the safety of complex systems, namely dams. Without requiring mathematical or statistical frameworks, it intends to assure that any plausible potential failure is considered and studied, in terms of: *what can go wrong? How and to what extent can it go wrong? What can be done to prevent or to mitigate it?* (dos Santos et al. 2012) (emphasis in original)

Resolution Copper has conducted a failure modes assessment for each tailings facility design (Klohn Crippen Berger Ltd. 2019a; Pilz 2019), identifying all potential failure modes, and identifying the design feature

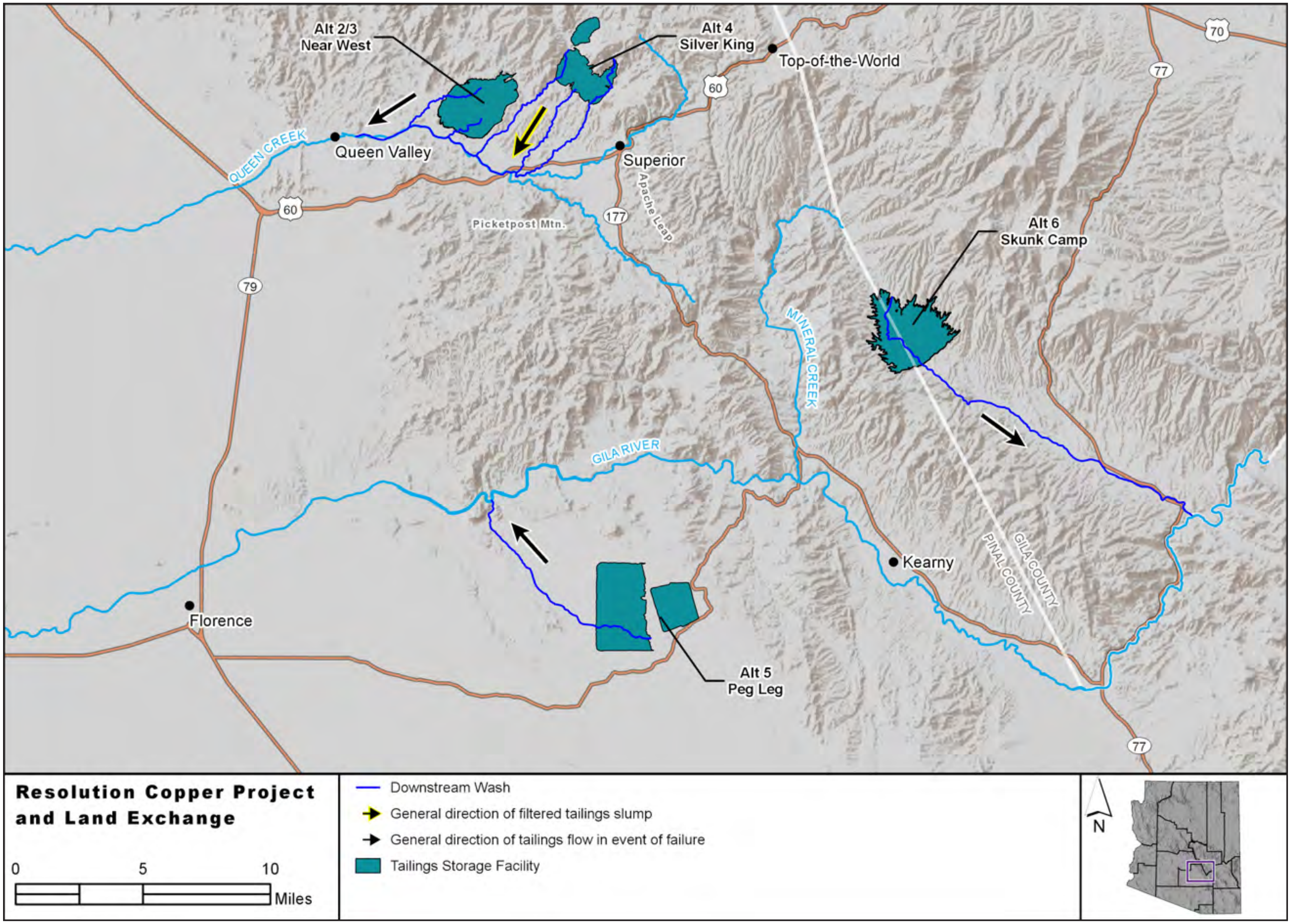


Figure 3.10.1-1. Overview of tailings safety analysis areas

to address each risk, in line with best industry practice, international design standards, and Federal and State regulations. The Forest Service reviewed the failure modes assessment, found it appropriate for the level of alternative design, and has included a discussion of the work in "Summary of Applicant-Committed Environmental Protection Measures" in section 3.10.1.4.

BREACH ANALYSIS

A breach analysis is used to model a tailings storage facility failure, including the volume of tailings released and how far it would run downstream. Some methods require no site-specific information except for basic facility design (such as embankment height or total facility volume). These methods include the empirical, rheological, and energy balance methods. Other methods use numerical modeling with the incorporation of detailed site-specific information. See Newell and Garrett (2018c) for further information on these techniques.

For the DEIS, the Forest Service has chosen the following empirical method to disclose the effects of a failure. As noted in the following text, this approach likely represents a worst case. It does not consider embankment type, design features used to specifically address failure modes, foundation conditions, operational approaches, or real-world topography.

Rico Empirical Method

Empirical methods use the known, available characteristics of historical tailings facility failures in order to estimate the characteristics of a failure at a hypothetical future tailings facility. Empirical methods are often based on limited data, perhaps only the basic geometry of the facility (embankment height, total volume), rather than specific embankment design details and foundation conditions. This approach was introduced by Rico et al. (2007), who relied on a database of 29 known tailings facility failures worldwide that occurred between 1965 and 2000. This empirical method was updated in 2018 by Larrauri and Lall (2018) to include additional known failures, for a total of 35 worldwide tailings facility failures between 1965 and 2015. The Larrauri and Lall dataset includes the two largest and most recent failures (at the time): Mount Polley Mine in British Columbia in 2014, and Fundão in Brazil in 2015.

These researchers developed two statistical relationships. The first relationship predicts the volume of material released during a failure based on the total facility volume. Fundamentally this approach comes down to a basic equation that shows historic releases have on average released about 33 percent of the total facility volume. The second relationship predicts the maximum travel distance downstream based on the release volume and the embankment height.

There are substantial limitations to the empirical approach:

- The largest facility in the dataset is 74 million cubic meters,[61] compared with 1,000 million cubic meters (upon buildout) for the planned Resolution Copper facility. For this project, the extrapolation goes well beyond the bounds of the original dataset; this represents an uncertainty since larger facilities may or may not react like smaller facilities.
- Specific embankment construction methods are not factored into the empirical equations. Of the 35 facilities included in the Larrauri and Lall estimates, 24 used an upstream construction method, one used modified centerline (matching Alternatives 2 and 3), and none used centerline (matching Alternatives 5 and 6) (Bowker 2019). The empirical dataset is therefore not representative of the specific design proposed by Resolution Copper. The Resolution Copper facility would have a fundamentally different type of embankment than most of the previous failures (instead of an upstream embankment, Alternatives 2 and 3 use a modified-centerline, and Alternatives 5 and 6 use a centerline embankment).

61. The most common unit of volume used in the literature on tailings releases is cubic meters, or millions of cubic meters. For ease and consistency, these same units are being used in this section.

- The dataset extends as far back as 1965 and may have been designed to lower factors of safety or higher acceptable levels of risk; the Resolution Copper facility would be designed to modern standards (described in more detail in "Relevant Laws, Regulations, Policies, and Plans" in section 3.10.1.3).
- The empirical estimates are based solely on embankment height or facility volume and take no account of operational methodologies, topography, or actual failure mode.

While recognizing these limitations, the Forest Service has selected the empirical method as the most reasonable method for the DEIS to inform the NEPA process and assess differences between alternatives. The level of current design and site-specific information is sufficient to use the empirical method, and the downstream effects reflect the real-world conditions experienced during other failures.

3.10.1.3 Affected Environment

Relevant Laws, Regulations, Policies, and Plans

The regulations and policies that guide the design, construction, operation, and closure of tailings storage facilities come from a variety of sources. Some guidance is required to be met, such as the requirements of the National Dam Safety Program, Arizona State Mine Inspector's office, or Arizona APP program, while other guidance is followed voluntarily as part of industry best practices. What is considered acceptable in the design of a tailings storage facility is evolving as the industry and government respond to a number of recent and widely publicized catastrophic tailings failures. In this section, the Federal, State, and industry design standards are summarized, as well as recent proposals for better risk-based tailings design methods; ultimately, the design proposed by Resolution Copper is shown to meet the most stringent of these standards.

RECENT FAILURES

Post-failure investigations by independent industry experts were conducted in the Mount Polley (2014) and Fundão (2015) tailings failures. Both of these events are discussed here because they provide useful examples of the chain of events that can lead to a catastrophic failure, and because they underscore the need for stringent design requirements, regulatory oversight, and governance. In January 2019, another tailings embankment failure in Brazil at the Córrego do Feijão facility resulted in the estimated deaths of over 300 people. The post-failure investigation for this catastrophe is likely to take a year or more to complete, and at this time little is known about the cause of the Córrego do Feijão failure.

Mount Polley Failure (2014)

The Mount Polley investigative panel considered a wide range of potential failure modes that could have contributed to the failure (Mining and Mineral Resources Division 2015). Ultimately, the panel determined that the primary reason for the failure was the lack of understanding of the foundation conditions and how the increasing embankment height would change the foundation behavior. Specifically, the site characterization undertaken below a secondary embankment used to help impound the tailings prior to construction failed to identify the nature of glacial lakebeds in the subsurface, and therefore the design did not take into account the complexity of the foundation materials. As the embankment height increased, the geological unit in question changed properties and became susceptible to "undrained loading," which means that under the great load of the tailings, this geological unit compressed and developed excess pore pressure, reducing the shear strength. These were factors that are well known and studied in soil mechanics but were not understood or applied correctly in the design process.

An additional aspect of the design that contributed to the failure was the use of a steep slope on the downwards face of the embankment (1.3:1). The original design criteria for the embankment called for a 2:1 slope, but that slope had not yet been achieved due to a lack of available rock fill material until later in the life of the tailings facility. The panel

concluded that the embankment likely would not have failed if the 2:1 design slope had been achieved.

Although not a cause of the failure, the primary factor in the severity of the failure was the excess amount of water stored in the facility. When the failure occurred, permitting was still underway to allow treatment and discharge of the excess stored water downstream.

In summary, the Mount Polley failure resulted from the following:

- shortcomings in site characterization,
- inadequate design resulting from the flawed site characterization,
- inadequate construction resulting from temporary deviations from the original design due to logistical issues (availability of waste rock),
- logistical delays with the discharge of excess water from the facility, which increased the severity of the consequences of failure, and
- failure of regulatory oversight for adherence to design and operational parameters.

The Mount Polley failure released 21 to 25 million cubic meters of pond water and tailings. The failure of the embankment took place suddenly without any warning signs and became uncontrollable in less than 2 hours. Polley Lake (just upstream of the breach), Hazeltine Creek, and Quesnel Lake were impacted by the debris flow, and the discharge of water from Polley Lake was blocked by the tailings plug left behind (Golder Associates Ltd. 2015; Mining and Mineral Resources Division 2015). The tailings release impacted about 5 to 6 miles of Hazeltine Creek before entering Quesnel Lake. There was no loss of human life.

At the immediate discharge location, tailings were estimated to be 11 to 12 feet thick. Along Hazeltine Creek, the debris flow scoured some areas to bedrock (estimated 1.2 million cubic meters of material lost) and tailings deposits covered other areas (estimated 1.6 million cubic meters of material deposited). Authorities estimated that Quesnel Lake received almost 19 million cubic meters of tailings, eroded material, and discharged water. The discharge completely destroyed the aquatic habitat in Hazeltine Creek. It also affected the water quality in Quesnel Lake and Polley Lake through increased turbidity and copper content. Initial assessments within the first year after the release found relatively little permanent or ongoing impact on aquatic life or terrestrial life, but studies continue (Golder Associates Ltd. 2015).

Fundão Failure (2015)

The Fundão investigative panel determined that a chain of decisions made during operations ultimately led to the failure of the embankment (Fundão Tailings Dam Review Panel 2016). First, damage to the original starter dam resulted in a change of design that allowed for an increase of saturation in the facility beyond the original plans. Second, a series of unplanned deviations in the facility construction resulted in deposition of fine-grained tailings at unintended locations, and the subsequent raising of the embankment above these tailings. This unintended deposition was a result of a design flaw—an inadequate concrete structure below the embankment that prevented the original design from being implemented—but also a deviation in tailings and water management over several years, in which water was allowed to encroach much closer to the crest of the embankment than originally planned.

The stresses placed on the fine-grained materials underlying the embankment caused them to shift, ultimately weakening the embankment to “a precarious state of stability” (Fundão Tailings Dam Review Panel 2016). Ninety minutes before the failure a series of small earthquakes occurred, and these seismic shocks triggered the failure. The panel was careful to note that while the seismic event was the trigger mechanism, it was not the ultimate cause of the failure.

In summary, the Fundão failure resulted from the following:

- deviations from the original design that allowed greater saturation in the facility;

- deviations in the location of planned tailings deposition caused by an unexpected problem with a foundation structure;
- deviations in the location of planned tailings deposition caused by deviations from tailings and water management criteria;
- a seismic shock that triggered the failure of the already compromised embankment; and
- failure of regulatory oversight for adherence to design and operational parameters.

The Fundão embankment failure released 32 million cubic meters of tailings. The failure of the embankment took place suddenly, within 2 hours of the triggering earthquakes. The United Nations estimated that the tailings release ultimately traveled 620 km downstream, following the Gualoxo and Doce Rivers, to reach the Atlantic Ocean. The town of Bento Rodrigues was immediately downstream of the facility; over a dozen people lost their lives, an estimated 600 families were displaced, and the drinking water supply to over 400,000 people was disrupted (GRID-Arendal 2017). The tailings destroyed an estimated 3,000 to 4,000 acres of riparian forest and destroyed substantial aquatic habitat.

Both of these failures (and others) involved a combination of design, construction, and operational factors, specifically the role of water, that contributed to the final outcome. Industry best practice is evolving to understand that each of these issues must be managed in an overall management plan or system that reviews the design and construction process throughout the life of the facility to prevent such future incidents.

EVOLVING INDUSTRY DIRECTION TOWARD AN INTERNATIONAL STANDARD ON TAILINGS STORAGE FACILITIES

In 2018, Dr. Norbert Morgenstern delivered a lecture to the Brazilian Geotechnical Congress on the topic of Geotechnical Risk, Regulation and Public Policy (Morganstern 2018). Dr. Morgenstern noted that the recent high-profile failures have occurred "at locations with strong technical experience, conscientious operators and established regulatory procedures." As part of that lecture, Dr. Morgenstern proposed a system for Performance-Based Risk-Informed Safe Design (PBRISD), construction, operation, and closure of tailings storage facilities. He further urged the International Council on Mining and Metals (ICMM) to support this proposed system and to facilitate its adoption in practice. In addition, Dr. Morgenstern praised The Mining Association of Canada's (MAC's) "Guide for the Management of Tailings Facilities" (Mining Association of Canada 2019) and noted the guide's influence on "governance protocols needed to ensure safe tailings management from the conceptual stages through to closure."

The ICMM is an international organization representing 27 signatory mining and metals companies, including Rio Tinto and BHP, partners in Resolution Copper. The ICMM also represents 36 associations, including the MAC and the National Mining Association. Through these members, the ICMM delivers best practice guidelines and industry standards.

Following the 2014 tailings failure at the Mount Polley Mine in British Columbia, MAC launched a comprehensive internal and external review of their Tailings Guide. The resulting recommendations included "a risk-based ranking classification system for non-conformances and have corresponding consequences." The recommendations also asked that guidance on risk assessment methodology be included. MAC noted that the resulting third edition of the Tailings Guide "is another step in the continual improvement process for tailings management, moving toward the goal of minimizing harm: zero catastrophic failures of tailings facilities, and no significant adverse effects on the environment and human health" (Mining Association of Canada 2019). Of note, the current edition includes a risk-based approach, "managing tailings facilities in a manner commensurate with the physical and chemical risks they may pose." The revised guidance specifies: (1) regular, rigorous risk assessment; (2) application of most appropriate technology to manage risks on a site-specific basis (best available technology); (3) application of industry best practices to manage risk and achieve performance objective (best available performance); and (4) use of rigorous, transparent decision-making tools to select the most

appropriate site-specific combination of best available technology and location for a tailings facility.

In February 2019, and in response to the recent Brumadinho tailings embankment failure in Brazil, the ICMM announced that it would establish an independent panel of experts to develop an international standard for tailings facilities (International Council on Mining and Metals 2019b). According to ICMM, this standard is expected "to create a step change for the industry in the safety and security of these facilities." The details of the standard are expected to include (1) a global and transparent consequence-based tailings facility classification system with appropriate requirements for each level of classification; (2) a system for credible, independent reviews of tailings facilities; and (3) requirements for emergency planning and preparedness.

In support of developing an international standard, ICMM's response to the Brumadinho failure also announced that the supporting guidance would include PBRISD, as recommended by Dr. Morgenstern, a conformance guide for ICMM's tailings governance framework, and a critical controls management framework (International Council on Mining and Metals 2019a). The fundamental principle of a PBRISD tailings management system is accountability, achieved only by multiple layers of review, recurrent risk assessment, and performance-based validation, from construction through closure (Morganstern 2018).

Further to ICMM's initial announcement, in March 2019, they announced they would co-convene the independent review along with the United Nations Environment Programme (UNEP) and the Principles for Responsible Investment (PRI) (International Council on Mining and Metals 2019c). This partnership will encourage more broad acceptance of the eventual international standard, while still requiring commitment to it by ICMM's member companies. The independent review is anticipated to conclude by the end of 2019.

FEDERAL REQUIREMENTS FOR TAILINGS FACILITY DESIGN

Regulatory jurisdiction over a tailings embankment and facility depends largely on the location. If the tailings facility is located fully or in part on Federal land administered by the BLM or Forest Service, then tailings design and safety are analyzed and approved as part of the review process for the mining plan of operations, and a bond is required for any reclamation requirements associated with the tailings embankment. Mineral regulations specifically give the Forest Service the ability to regulate tailings: "All tailings, dumpage, deleterious materials, or substances and other waste produced by operations shall be deployed, arranged, disposed of or treated as to minimize adverse impact upon the environment and forest surface resources" (36 CFR 228.8(c)).

The BLM's mining regulations require the "prevention of unnecessary or undue degradation" (43 CFR 3809), in addition to the applicable considerations for surface use and occupancy (43 CFR 3715). This gives the BLM the authority and ability to regulate tailings storage facilities on BLM-administered land. This would apply to Alternative 5 – Peg Leg.

While neither BLM nor Forest Service guidance contains prescriptive[62] requirements for how tailings embankments must be constructed, the Federal Emergency Management Agency (FEMA) has developed the National Dam Safety Program, which includes standards that are applicable to structures constructed on Federal land. This includes tailings embankments. The National Dam Safety Program provides a conceptual framework that includes requirements for site investigation and design, construction oversight, operations and maintenance, and emergency planning, as outlined in table 3.10.1-1 (Federal Emergency Management Agency 2004, 2005, 2013).

The Forest Service would require that the Resolution Copper tailings storage facility adhere to National Dam Safety Program guidelines, if

62. For the purposes of this discussion, a "prescriptive" design requirement is one where a specific technique or value is dictated by the guidance, rather than a conceptual or qualitative objective. For example, FEMA standards for "factor of safety" are non-prescriptive: "Factors of safety should be appropriate to the probability of the loading conditions . . . ," whereas APP standards for factor of safety are prescriptive: "Static stability analyses should indicate a factor of safety of at least 1.3."

Table 3.10.1-1. Overview of key requirements of National Dam Safety Program and comparison with other guidance

National Dam Safety Program Process/ Components	Specific FEMA Guidance	Arizona BADCT Guidance	Rio Tinto (2015)	ICMM (2016)	CDA (2014)	MAC (2017)	ANCOLD (2012)	MEM (2017)	USACE (2002, 2004)
Site Investigation and Design									
Hazard classification	III.B.1.a (FEMA 93) FEMA 333				X		X	X	
Selection of inflow design flood	III.B.1.b-c (FEMA 93) FEMA P-94	E.3.2, E.3.3, E.3.4			X		X	X	X
Selection of the hydraulic capacity of embankment	III.B.1.d (FEMA 93)	3.5.4.2; E.3.5			X		X		X
Seismic investigations	III.B.2.a-d (FEMA 93)	3.5.3.3; E.2.4.6					X		
Selection of design earthquake	III.B.2.e-f (FEMA 93) FEMA 65	3.5.3.3; E.2.4.3			X		X	X	X
Geotechnical aspects									
Site-specific exploration	III.B.3.a-b (FEMA 93)	3.5.3.2; E.2.3					X		X
Geotechnical design	III.B.3.c (FEMA 93)	3.5.3.3			X		X		X
Foundation treatment to ensure stability, control seepage, and minimize deformation	III.B.3.d (FEMA 93)	3.5.4.1			X		X		X
Embankment design parameters									
Site-specific design	III.B.5.a (FEMA 93)	3.5.3					X		X
Material evaluation	III.B.5.b (FEMA 93)	E.2.3					X		X
Seismic design	III.B.5.d.1 (FEMA 93)	3.5.4.4; E.2.4.3; E.2.4.6			X		X	X	X
Stability/factors of safety	III.B.5.d.2 (FEMA 93)	3.5.4.4; E.2.4.3; E.2.4.5			X		X	X	X
Settlement and cracking	III.B.5.d.3 (FEMA 93)	E.2.4.3					X		X
Seepage control	III.B.5.d.4 (FEMA 93)	3.5.4.3			X		X		X
Zoning to ensure stability and seepage control	III.B.5.d.5 (FEMA 93)								X
Erosion protection	III.B.5.d.6 (FEMA 93)						X		X
Construction management									
Inspection	III.B.3.f (FEMA 93)		X	X		X	X		X
Reevaluation of design	III.B.5.f (FEMA 93) III.C.2 (FEMA 93)		X				X		X
Construction quality assurance and testing	III.C.4 (FEMA 93)		X			X	X	X	X
Operations and maintenance									

continued

Table 3.10.1-1. Overview of key requirements of National Dam Safety Program and comparison with other guidance *(cont'd)*

National Dam Safety Program Process/ Components	Specific FEMA Guidance	Arizona BADCT Guidance	Rio Tinto (2015)	ICMM (2016)	CDA (2014)	MAC (2017)	ANCOLD (2012)	MEM (2017)	USACE (2002, 2004)
Develop written operating and maintenance procedures	III.D.1.b-c (FEMA 93)	3.5.4.5	X	X	X	X	X	X	X
Periodic inspection	III.D.2.a-b (FEMA 93)	3.5.4.6	X	X	X	X	X	X	X
Instrumentation	III.B.3.e (FEMA 93) III.B.5.e (FEMA 93) III.D.2.c (FEMA 93)						X		X
Correction of deficiencies	III.D.2.d (FEMA 93)		X	X		X	X	X	X
Emergency Planning	III.A.1.f (FEMA 93) III.B.1.e-f (FEMA 93) III.D.3 (FEMA 93)								
Determine failure modes	III.D.3.b.1 (FEMA 93)								X
Inundation maps or breach analysis	III.D.3.b.2-3 (FEMA 93)				X		X	X	
Response times	III.D.3.b.4 (FEMA 93)								
Emergency action plan	III.D.3.c-d (FEMA 93)		X	X	X	X	X	X	X
Other aspects									
Use of outside review	III.A.6 (FEMA 93)		X	X	X	X	X	X	
Risk-based design	III.A.1.g (FEMA 93) 2.3.6 (FEMA P-94)		X	X	X	X	X	X	
Closure/Post-closure design	*	3.5.5	X	X	X	X	X	X	
Accountability	*		X	X	X	X		X	
Change management and documentation	*		X	X		X		X	X

Sources: Rio Tinto (2015); International Council on Mining and Metals (2016); CDA = Canadian Dam Association (2014); Mining Association of Canada (2017); ANCOLD = Australian National Committee on Large Dams Inc. (2012); MEM = Ministry of Energy and Mines (2017); U.S. Army Corps of Engineers (2002) and U.S. Army Corps of Engineers (2004)

Notes:

FEMA 93 = Federal Guidelines for Dam Safety, April 2004

FEMA 333 = Federal Guidelines for Dam Safety, Hazard Potential Classification System for Dams, April 2004

FEMA P-94 = Selecting and Accommodating Inflow Design Floods for Dams, August 2013

FEMA 65 = Federal Guidelines for Dam Safety, Earthquake Analyses and Design of Dams, May 2005

* While components of the National Dam Safety Program standards touch on these topics, they are not handled in great specificity or detail.

built on Federal land. This is included in the "Adherence to National Dam Safety Program Standards" part of the "Mitigation Effectiveness" section as a required mitigation on Federal land.

STATE REQUIREMENTS FOR TAILINGS FACILITY DESIGN

The APP program administered by the ADEQ contains prescriptive requirements for tailings embankments. While focused on protecting aquifer water quality, the APP program requires that tailings storage facilities are designed to meet the standards of Best Available Demonstrated Control Technology (BADCT). The BADCT guidance provides specific recommended geotechnical criteria for static stability and seismic stability of tailings embankments, including minimum design earthquake magnitude, factors of safety for various loading conditions, and maximum deformation under seismic loading (see Section 3.5 – Tailings Impoundments, in Arizona Department of Environmental Quality (2004)).

The Forest Service cannot ultimately approve a plan of operations that violates an applicable law or regulation. Eventually the issuance of an Aquifer Protection Permit by the ADEQ to Resolution Copper would demonstrate to the Forest Service that the project complies with applicable Arizona laws and regulations. For the purposes of the DEIS, it is therefore assumed that APP prescriptive BADCT requirements must be met. The overlap of the Aquifer Protection Permit BADCT requirements with the National Dam Safety Program requirements is shown in table 3.10.1-1.

INDUSTRY BEST PRACTICES

The mining industry has adopted a number of industry standards and best practices that are equally or more restrictive than the requirements of either the National Dam Safety Program or the APP program. These are shown in comparison to the National Dam Safety Program and APP program in table 3.10.1-1 (Australian National Committee on Large Dams Inc. 2012; International Council on Mining and Metals 2016; Mining Association of Canada 2017; Ministry of Energy and Mines 2017; Rio Tinto 2015; U.S. Army Corps of Engineers 2002, 2004).

There are number of concepts in these documents that represent industry best practices that are not strongly represented in the National Dam Safety Program or APP program standards. These include the following:

- *Risk-based design.* FEMA standards allow for risk-based design as an option (see for example FEMA P-94, Section 2.3.6, Risk-Informed Hydrologic Hazard Analysis), but do not require it, as these techniques were still evolving and yet to be widely used when FEMA's primary guidance was developed. A risk-based design approach can be used to "fine-tune" design parameters, but only when appropriate and within certain bounds.
- *Design for closure.* FEMA standards are largely silent on the issue of closure and post-closure of tailings facilities, instead focusing primarily on the design, construction, and operation of embankments.
- *Accountability.* FEMA standards require qualified personnel be used, but do not specify a single individual accountable for the design, construction, or management of the tailings storage facility.
- *Change management.* FEMA includes various requirements for documentation; however, industry best practices include a strong focus on managing and evaluating deviations from the original design, construction, or operation plan.
- *Independent review.* One common feature in many of the industry best practices listed here is the use of independent technical review by an outside expert or panel of experts. Resolution Copper has employed an Independent Technical Review Board (ITRB) to review the tailings design, drawing

on professionals with recognized expertise in tailings design and management[63] (Resolution Copper 2017). The ITRB has made a number of specific comments on design considerations for liquefaction, seismic loading, design factors for seismic and flood risk, and seepage controls.

APPROPRIATENESS OF RESOLUTION COPPER PROPOSED DESIGN

Many of the design standards that Resolution Copper must comply with, particularly those of the National Dam Safety Program, are narrative and non-prescriptive in nature. Key design parameters that are prescriptive and readily comparable between guidance documents are shown in table 3.10.1-2. The designs developed by Resolution Copper meet the most stringent of these standards, whether required (National Dam Safety Program or Aquifer Protection Permit program) or solely industry best practice.

Existing Conditions and Ongoing Trends

DOWNSTREAM COMMUNITIES

The tailings alternatives are located upstream of population centers in central Arizona that could be affected in the event of a failure. Communities in the approximate flowpath are shown in table 3.10.1-3, for roughly 50 miles downstream.[64] For Alternatives 2 and 3, the hypothetical flowpath of a tailings release is assumed to follow Queen Creek, through Whitlow Ranch Dam, through the community of Queen Valley, through urban development in the East Salt River valley, and eventually onto the Gila River Indian Community. For Alternative 5, the hypothetical flowpath is assumed to follow Donnelly Wash to the Gila River, and then downstream through Florence and eventually onto the Gila River Indian Community. For Alternative 6, the hypothetical flowpath is assumed to follow Dripping Spring Wash to the Gila River toward Winkelman, Hayden, and Kearny.

DOWNSTREAM WATER SUPPLIES

The tailings facilities are also upstream of substantial water supplies in central Arizona, both community potable water systems and agricultural irrigation districts, as shown in table 3.10.1-4. In the event of a tailings failure, water supplies would be at risk from destruction of infrastructure and potential contamination of surface water and groundwater sources.

DOWNSTREAM WATERS AND HIGH-VALUE RIPARIAN AREAS

Riparian Areas Downstream of Tailings Storage Facility

High-value riparian ecosystems exist downstream of all of the tailings alternative locations. These include the following:

- Queen Creek at Whitlow Ranch Dam (downstream of Alternatives 2, 3, and 4). Perennial flow occurs in Queen Creek at Whitlow Ranch Dam, which is the outlet for subsurface flow in the Superior Basin. Approximately 45 acres of riparian vegetation have grown up behind Whitlow Ranch Dam, supported by flowing surface water and shallow groundwater. There is a dense understory. Saltcedar dominates the woody vegetation, although other riparian tree species are also present,

63. The four members of Resolution Copper's ITRB are David Blowes, Ph.D. (University of Waterloo), David A. Carr (Registered Geologist), Richard Davidson (Professional Engineer), and Norbert Morgenstern, Ph.D. (Professional Engineer; Professor Emeritus, University of Alberta; Chair of the Mount Polley Independent Expert Engineering Investigation and Review Panel; Chair of the Fundão Tailings Dam Investigation Panel).

64. While the empirical estimates discussed in section 3.10.1.4 indicate that tailings could go farther than 50 miles in the event of a catastrophic failure, this analysis focuses on communities in the East Salt River valley and along the Gila River that would be within 50 miles of the tailings storage facility alternative, that have the highest likelihood of being impacted if a catastrophic failure were to occur.

Table 3.10.1-2. Comparison of key design criteria against requirements of National Dam Safety Program, Aquifer Protection Permit program, and industry best practices

	Downstream Slope	Minimum Factor of Safety (Static)	Minimum Factor of Safety (Dynamic or Seismic)	Design Earthquake	Inflow Design Flood	Independent Review	Breach Analysis and Emergency Planning
FEMA National Dam Safety Program (Required)	No specific requirement	1.5	1.2	Maximum Credible Earthquake (for high-hazard dam)	Probable Maximum Flood (for high-hazard dam)	No specific requirement	Determine failure modes; prepare inundation maps; time available for response; develop emergency action plans
Aquifer Protection Permit program BADCT (Required)	No specific requirement	1.3 to 1.5	1.0 to 1.1	Maximum Credible Earthquake (for risk to human life)	Probable Maximum Flood (for risk to human life)	No specific requirement	No specific requirement
Industry best practices	No steeper than 2H:1V (Ministry of Energy and Mines 2017)	1.5 (Ministry of Energy and Mines 2017) 1.3 to 1.5 (Australian National Committee on Large Dams Inc. 2012)	1.0 to 1.2 (Australian National Committee on Large Dams Inc. 2012)	2,475-year return period (Ministry of Energy and Mines 2017) 10,000-year return period up to Maximum Credible Earthquake (Canadian Dam Association 2014) 10,000-year return period up to Maximum Credible Earthquake (Australian National Committee on Large Dams Inc. 2012)	1,000-year return period up to Probable Maximum Flood (Canadian Dam Association 2014) 975-year return period, with 72-hour duration (Ministry of Energy and Mines 2017) 100,000-year return period up to Probable Maximum Flood (Australian National Committee on Large Dams Inc. 2012)	Required by most industry standards	Emergency action plans required by most industry standards; inundation maps required by Australian National Committee on Large Dams Inc. (2012), Canadian Dam Association (2014), and Ministry of Energy and Mines (2017)

continued

Table 3.10.1-2. Comparison of key design criteria against requirements of National Dam Safety Program, Aquifer Protection Permit program, and industry best practices *(cont'd)*

	Downstream Slope	Minimum Factor of Safety (Static)	Minimum Factor of Safety (Dynamic or Seismic)	Design Earthquake	Inflow Design Flood	Independent Review	Breach Analysis and Emergency Planning
Resolution Copper design	Alternative 2 has a 4H:1V slope, and Alternatives 3, 5, and 6 all have a 3H:1V slope	1.5	1.2	Maximum Credible Earthquake Analysis indicates Maximum Credible Earthquake is equivalent to 10,000-year return period. The 10,000-year design earthquake is based on a mean value; the 95th percentile of the 10,000-year event was also considered.	Probable Maximum Flood, 72-hour duration	Use of ITRB to oversee tailings design process	Not yet completed. This would be a required step for the preferred alternative based on site-specific information and design.
Comparison of Resolution Copper criteria to guidelines	Slope is less steep than the most stringent prescriptive standard	Static factor of safety meets the most stringent prescriptive standard	Dynamic factor of safety meets the most stringent prescriptive standard	Design earthquake meets the most stringent prescriptive standard	Design flood meets the most stringent prescriptive standard	Review by ITRB is consistent with the industry standard	Not yet met, but would be met for preferred alternative

Table 3.10.1-3. Communities and populations within 50 miles downstream of proposed tailings facilities

	Alternatives 2 and 3 – Near West Location	**Alternative 4 – Silver King Location**	**Alternative 5 – Peg Leg Location**	**Alternative 6 – Skunk Camp Location**
Nearest downstream residence	0.3 miles	4.5 miles	Directly adjacent	4 miles
Other points of interest		Boyce Thompson Arboretum = 3.7 miles		
Major communities				
1–10 miles downstream	Queen Valley CDP (654)	Queen Valley CDP (654)		Dripping Springs CDP (165)
11–20 miles downstream	San Tan Valley CDP (90,665)			
21–30 miles downstream	Town of Queen Creek (33,298) Town of Gilbert (232,176)		Town of Florence (26,066) Blackwater CDP [Gila River Indian Community] (1,653)	Town of Winkelman (262) Town of Hayden (483)
31–40 miles downstream	City of Chandler (245,160)		Sacaton Flats Village CDP [Gila River Indian Community] (457)	Town of Kearny (2,249)
41–50 miles downstream	Lower Santan Village CDP [Gila River Indian Community] (395) Stotonic Village CDP [Gila River Indian Community] (379) Sweet Water Village CDP [Gila River Indian Community] (152)		Sacaton CDP [Gila River Indian Community] (2,338) Upper Santan Village CDP [Gila River Indian Community] (391) Lower Santan Village CDP [Gila River Indian Community] (395) Stotonic Village CDP [Gila River Indian Community] (379) Sweet Water Village CDP [Gila River Indian Community] (152)	
Estimated population within 50 miles	*602,879*		*31,831*	*3,159*

Source: ACS 2013–2017 5-year Estimates: Total Population (U.S. Census Bureau 2018).

Note: CDP = Census designated place

Table 3.10.1-4. Water supplies in central Arizona within 50 miles downstream of proposed tailings facilities

Water Supply	Population/ Acreage Served	Source of Water	Downstream of Alternatives
Community Water Systems			
Queen Creek Water Company	74,842	Groundwater (wells within 2,000 feet of Queen Creek)	Alternatives 2 and 3
Town of Gilbert	247,600	Surface water (SRP, CAP); Groundwater (wells directly adjacent to Queen Creek)	Alternatives 2 and 3
Apache Junction (Arizona Water Company)	57,647	Groundwater (wells 10–11 miles from Queen Creek)	Alternatives 2 and 3
Superior (Arizona Water Company)	3,894	Groundwater (wells 3–4 miles from Queen Creek)	Alternatives 2 and 3
Central Arizona Project	~850,000	Delivery of surface water to over a dozen downstream contract holders, including systems serving Tucson, Florence, Marana, Coolidge, and Casa Grande	Alternatives 2, 3, 5, and 6
Diversified Water Utilities	3,868	Groundwater (wells directly adjacent to Queen Creek)	Alternatives 2 and 3
Queen Valley Domestic Water Improvement District	1,000	Groundwater (wells directly adjacent to Queen Creek)	Alternatives 2 and 3
City of Chandler	247,328	Surface water (SRP, CAP); Groundwater (wells 1–2 miles from Queen Creek)	Alternatives 2 and 3
Johnson Utilities	62,158	Groundwater (wells 1–2 miles from Queen Creek)	Alternatives 2 and 3
Town of Florence	14,880	Groundwater (wells directly adjacent to Gila River)	Alternative 5
Johnson Utilities – Anthem at Merrill Ranch	7,028	Groundwater (wells 1–2 miles from Gila River)	Alternative 5
Gila River Indian Community – Casa Blanca/Bapchule	2,603	Groundwater (well locations unknown)	Alternative 5
Gila River Indian Community – Sacaton	5,307	Groundwater (well locations unknown)	Alternative 5
Winkelman (Arizona Water Company)	468	Groundwater (wells within 1,000 feet of Gila River)	Alternative 6
ASARCO Hayden Operations	779	Groundwater (wells directly adjacent to Gila River)	Alternative 6
Town of Hayden	870	Groundwater purchased from ASARCO	Alternative 6
Town of Kearny	2,070	Groundwater (wells directly adjacent to Gila River)	Alternative 6
Major Irrigation Districts			
New Magma Irrigation and Drainage District	~27,000 acres	Groundwater; CAP	Alternatives 2 and 3
Queen Creek Irrigation District	~16,000 acres	Groundwater; CAP	Alternatives 2 and 3
San Tan Irrigation District	~3,000 acres	Groundwater; CAP	Alternatives 2 and 3
San Carlos Irrigation and Drainage District	~50,000 acres	Surface water (Gila River); CAP; Groundwater	Alternatives 5 and 6

including cottonwood and willow. This area is important to birding and outdoor recreation. Endangered southwestern willow flycatchers have been documented in this habitat in ongoing surveys conducted by Resolution Copper; endangered western yellow-billed cuckoo have not been detected during surveys, but the habitat is appropriate for the species.

- Gila River between Dripping Spring Wash and Ashurst-Hayden Dam (downstream of Alternatives 5 and 6). This reach of the Gila River is generally perennial, though flow is regulated by releases from the San Carlos Reservoir upstream. A riparian gallery exists along substantial portions of this reach, dominated by saltcedar, with some mesquite, cottonwood, willow, and wet shrublands (Stromberg et al. 2005). This reach of the Gila River includes critical habitat for the endangered southwestern willow flycatcher and proposed critical habitat for the threatened western yellow-billed cuckoo and northern Mexican gartersnake, and is habitat for a number of native species (desert sucker, Gila longfin dace, Sonoran sucker, roundtail chub), amphibians (lowland leopard frog), reptiles (desert tortoise, box turtle), and bats (pallid bat, pale Townsend's big-eared bat, and California leaf-nosed bat). Recreational activities along this stretch of the Gila River include hiking, birding, and camping, particularly along the Arizona Trail, which crosses the Gila River downstream of Kearny. Additionally, the abandoned town of Cochran, Arizona and the associated coke ovens are accessible from this stretch of the Gila River.
- Approximately 7.5 miles of the Gila River from Dripping Spring Wash to the town of Winkelman was studied by the BLM, according to the Wild and Scenic Rivers Act, and was determined to be suitable for addition to the National Rivers System in 1997, with a "recreational" classification. The outstandingly remarkable values identified in the area are scenic, fish, and wildlife habitat. This river segment includes two developed recreation sites, providing access to the river for wildlife, viewing, fishing, hunting, camping, and picnicking (Bureau of Land Management 1994a).
- A number of wetland[65] areas are associated with the Gila River (downstream of Alternative 5). A large wetland complex has developed along the Gila River Indian Community's MAR-5 managed aquifer recharge project, located near Sacaton, Arizona. The community is planning to enhance this area with the development of the Gila River Interpretive Trail and Education Center.

Riparian Areas Crossed or Paralleled by Tailings and Concentrate Pipelines

Copper Concentrate Pipeline and Tailings Pipelines for Alternatives 2, 3, and 4

The copper concentrate pipeline route from the West Plant Site to the filter plant and loadout facility crosses a number of ephemeral washes that are tributary to Queen Creek: Silver King Wash, Rice Water Wash, Potts Canyon, Benson Spring Canyon, and Gonzales Pass Canyon. All contain some amount of xeroriparian habitat in linear strands along the drainage, typically mesquite, palo verde, ironwood, and desert shrubs in concentrations greater than found in the uplands. The width of xeroriparian habitat crossed by the pipeline varies, from roughly 50 feet to 500 feet wide. The copper concentrate pipeline route also parallels an ephemeral portion of Queen Creek upstream of Whitlow Ranch Dam, which has a well-developed xeroriparian community.

The tailings pipeline route to Alternatives 2 and 3 also crosses Silver King Wash, Rice Water Wash, and Potts Canyon, and the tailings pipeline route to Alternative 4 crosses Silver King Wash. Similar xeroriparian habitat exists at these crossings.

65. In this section, a number of references are made to wetland or riparian areas. The intent is to identify physical features on the landscape with high value for habitat, recreation, aesthetics, and other uses. These references to wetlands should not be construed to mean that these are jurisdictional waters of the U.S., as regulated under Section 404 of the Clean Water Act. That designation would be made by the USACE when appropriate.

Alternative 5 Tailings Pipeline – West Option

The west option for the tailings pipeline route for Alternative 5 crosses a number of ephemeral washes with similar xeroriparian habitat as that described earlier. These include Silver King Wash (tributary to Queen Creek), Cottonwood Canyon (tributary to Queen Creek), and Donnelly Wash (tributary to Gila River). Silver King Wash and Cottonwood Canyon vary in width from 100 to 500 feet; Donnelly Wash is a wider, braided wash with a width of roughly 1,000 feet.

The pipeline route also parallels Reymert Wash (tributary to Queen Creek) for roughly 2 miles; the xeroriparian corridor along this reach of the wash is generally 50 to 100 feet wide.

Where the pipeline route crosses Queen Creek it would be underground, installed using either trenching techniques or horizontal directional drilling. At this location, the stream is ephemeral, approximately 1,000 feet wide, with braided strands of xeroriparian vegetation.

Where the pipeline route crosses the Gila River it would be underground, installed using trenching techniques or horizontal directional drilling. At this location, the river is perennial, approximately 1,300 feet wide, and supports both aquatic habitat and hydroriparian vegetation as described previously.

Alternative 5 Tailings Pipeline – East Option

The eastern option for the tailings pipeline route for Alternative 5 crosses several ephemeral washes, including Zellweger Wash and Walnut Canyon, both tributaries to the Gila River, with similar xeroriparian habitat as that described earlier. Walnut Canyon has a riparian reach designated as part of the White Canyon ACEC. Important resources values in this area are outstanding scenic, wildlife, and cultural values.

Where the pipeline route crosses Queen Creek it would be underground, installed using either trenching techniques or horizontal directional drilling. At this location, the stream is ephemeral and approximately 400 feet wide; however, nearby the pipeline route also crosses an unnamed tributary that receives effluent from the Superior Wastewater Treatment Plant. Thick hydroriparian vegetation is supported along this wash, and the streamflow feeds a perennial reach of Queen Creek located a few hundred feet downstream.

The pipeline route also parallels a portion of upper Arnett Creek for about 2 miles, near SR 177. Arnett Creek in this area is largely ephemeral with xeroriparian habitat, but portions of Arnett Creek downstream of this location have perennial flow.

Where the pipeline route crosses the Gila River it would be underground, installed using trenching techniques or horizontal directional drilling. At this location, the river is perennial, approximately 1,000 feet wide, and supports both aquatic habitat and hydroriparian vegetation.

Alternative 6 Tailings Pipeline – North Option

The north option for the tailings pipeline route for Alternative 6 crosses several ephemeral washes tributary to Queen Creek, including Conley Springs Wash and Yellowjack Wash. Some xeroriparian vegetation is associated with these washes, but sparse due to the steep and rocky terrain. Queen Creek lies about 2 miles downstream of the pipeline crossings, and is generally intermittent in this area, but with some hydroriparian vegetation adjacent to the channel (cottonwood, sycamore, ash, walnut). The pipeline route also crosses Queen Creek itself in this same area.

The pipeline route crosses Devil’s Canyon (underground) upstream of where perennial flow first occurs. Within a few miles downstream Devil’s Canyon is characterized by perennial flow, flowing springs, deep pools, and a closed-canopy hydroriparian corridor (ash, sycamore, alder), with associated aquatic habitat. Near here the pipeline route crosses Rawhide Canyon, an ephemeral wash tributary to Devil’s Canyon, with relatively sparse xeroriparian habitat.

The pipeline route crosses both Lyons Fork, a tributary to Mineral Creek, and then parallels Mineral Creek for over 3 miles. Mineral Creek has perennial flow in this area, relatively dense hydroriparian vegetation (cottonwood, willow, sycamore, ash), and aquatic habitat.

Alternative 6 Tailings Pipeline – South Option

The south option for the tailings pipeline route for Alternative 6 is identical to the north route once the route crosses Devil's Canyon. The south option crossing at Devil's Canyon (currently planned as a pipe bridge, but potentially underground) is farther downstream than the north route, in an area with perennial flow and associated riparian and aquatic habitat. Before reaching Devil's Canyon, the pipeline route crosses several ephemeral washes on Oak Flat, including Oak Creek and Hackberry Canyon, both tributary to Devil's Canyon.

Near Superior, the south pipeline route follows the same route as the Alternative 5 east pipeline route, crossing Queen Creek, the unnamed wash with perennial flow from the wastewater treatment plant, and then paralleling Arnett Creek for several miles.

INFRASTRUCTURE

In addition to population centers, water supplies, and high-value riparian areas, a number of important transportation or water supply structures are downstream of the tailings facilities. These include the following:

- Whitlow Ranch Dam. Whitlow Ranch Dam is a flood control structure located on Queen Creek, immediately downstream of Alternatives 2 and 3. The dam was built in 1960 to reduce the risk of flood damage to farmland and developed areas including the communities of Chandler, Gilbert, Queen Creek, and Florence Junction, as well as the former Williams Air Force Base (now Phoenix-Mesa Gateway Airport). The USACE evaluated the structure in 2009 and rated it as inadequate (due to foundation seepage and piping), but with a low probability of failure (U.S. Army Corps of Engineers 2012b). The capacity of Whitlow Ranch is approximately 86 million cubic meters (Maricopa County Flood Control District 2018); the ability of the dam to retain or detain a tailings release from Alternatives 2 or 3 would depend on the specific size of a failure.
- East Salt River valley canals and flood control. Three major distribution canals are downstream of the flowpath of a hypothetical tailings release from Alternatives 2 or 3. The Eastern and Consolidated Canals pass through the communities of Chandler and Gilbert and are part of the SRP distribution system. The Roosevelt Canal is part of the Roosevelt Conservation District and parallels a major flood control structure, the East Maricopa Floodway. This floodway is essentially an urbanized extension of Queen Creek; the ability of the floodway to retain or detain a tailings release would depend on the specific size of a failure.
- Central Arizona Project aqueduct. The CAP aqueduct transports water from the Colorado River, through Lake Pleasant north of Phoenix, and then transits the East Salt River valley. The aqueduct crosses Queen Creek near the communities of Queen Creek and San Tan Valley; flows from Queen Creek bypass the canal using a syphon system. The canal is raised and tends to block overland flow along much of its length; the ability of the canal levee to retain or detail a tailings release would depend on the specific size of a failure. The CAP canal also crosses the Gila River near Florence, but unlike the Queen Creek crossing, the flows from the canal are routed below the Gila River. The aqueduct continues through Pinal County and provides water as far south as Tucson and Green Valley.
- Arizona Water Company infrastructure. The potable water pipeline serving the town of Superior is located within the MARRCO corridor and would be downstream of a potential tailings release from Alternatives 2 or 3. This system serves approximately 4,000 people.
- Ashurst-Hayden Dam, Northside Canal, Florence Casa Grande Canal. These water diversion structures are located east of Florence and form the headworks to divert water from the Gila River for irrigation, including to the San Carlos Irrigation and Drainage District.
- U.S. Route 60. U.S. 60 crosses Queen Creek near Florence Junction. This highway forms one of only a few regional connection between the Phoenix metropolitan area and the

communities of the central Arizona highlands (Globe–Miami) and the White Mountains of eastern Arizona (Show Low, Pinetop-Lakeside, Springerville).

- U.S. Route 77. U.S. 77 crosses the Gila River near Winkelman and Dripping Spring Wash near its confluence with the Gila River. This highway forms the main regional connector for the areas between Tucson and Globe, connecting to the Upper Gila valley at Safford and the White Mountains northeast of Globe.
- U.S. Route 79. U.S. 79 crosses the Gila River near Florence. This highway forms the main regional connector for the agricultural areas between Tucson and the East Salt River valley.
- Christmas, Shores, and Winkelman Campgrounds. These are improved recreational facilities located adjacent to the Gila River and important for water-based recreation activities.

3.10.1.4 Environmental Consequences of Implementation of the Proposed Mine Plan and Alternatives

Alternative 1 – No Action

Under the no action alternative, the tailings facility would not be constructed, pipelines would not be built, and there would be no risk to public health and safety associated with potential failure of a tailings embankment or pipelines.

Impacts Common to All Action Alternatives

EFFECTS OF THE LAND EXCHANGE

The Oak Flat Federal Parcel would leave Forest Service jurisdiction. The role of the Tonto National Forest under its primary authorities in the Organic Administration Act, Locatable Regulations (36 CFR 228 Subpart A), and Multiple-Use Mining Act is to ensure that mining activities minimize adverse environmental effects on NFS surface resources. The removal of the Oak Flat Federal Parcel from Forest Service jurisdiction negates the ability of the Tonto National Forest to regulate effects on these resources. However, nothing related to the tailings storage facilities is associated with the Oak Flat Federal Parcel, and the land exchange would not have an effect on public health and safety in this regard.

The offered lands parcels would enter either Forest Service or BLM jurisdiction. Section 3003 of the National Defense Authorization Act specifies that any land acquired by the United States is withdrawn from all forms of entry, appropriation, or disposal under the public land laws, location, entry, and patent under the mining laws, and disposition under the mineral leasing, mineral materials, and geothermal leasing laws.

Specific management of mineral resources on the offered lands would be determined by the agencies, but in general when the offered lands enter Federal jurisdiction, mineral exploration and development would not be allowed. Given these restrictions, no or little tailings-related activity would be expected to occur on the offered lands.

FOREST PLAN AMENDMENT

The Tonto National Forest Land and Resource Management Plan (1985b) provides guidance for management of lands and activities within the Tonto National Forest. It accomplishes this by establishing a mission, goals, objectives, and standards and guidelines. Missions, goals, and objectives are applicable on a forest-wide basis. Standards and guidelines are either applicable on a forest-wide basis or by specific management area.

A review of all components of the 1985 Forest Plan was conducted to identify the need for amendment due to the effects of the project, including both the land exchange and the proposed mining plan of operations (Shin 2019). No standards and guidelines were identified applicable to management of tailings from a safety perspective. See process memorandum (Shin 2019) for additional details.

SUMMARY OF APPLICANT-COMMITTED ENVIRONMENTAL PROTECTION MEASURES

A number of environmental protection measures are incorporated into the design of the project that would act to enhance tailings safety. These are non-discretionary measures and their effects are accounted for in the analysis of environmental consequences.

Applicant-committed environmental protection measures for tailings and pipeline safety include those outlined in the tailings design documents (Golder Associates Inc. 2018a; Klohn Crippen Berger Ltd. 2018a, 2018b, 2018c, 2018d, 2019d), the Tailings Corridor Pipeline Management Plan (AMEC Foster Wheeler Americas Limited 2019), the Concentrate Pipeline Corridor Management Plan (M3 Engineering and Technology Corporation 2019b), and the GPO (Resolution Copper 2016d).

Tailings Storage Facility Design and Operational Measures

The following measures that enhance the safety of the tailings storage facility have been incorporated into the tailings design:

- use modified centerline (Alternatives 2 and 3) or centerline embankment (Alternatives 5 and 6) for NPAG;
- use full downstream embankment for PAG tailings (Alternatives 5 and 6);
- perform thickening of both PAG, NPAG, and NPAG overflow tailings (Alternatives 2, 3, 5, and 6), and additional ultrathickening of NPAG tailings (Alternative 3);
- segregate PAG tailings into smaller separate cells (Alternatives 5 and 6); and
- use filtered tailings (Alternative 4).

A failure modes analysis has already been completed to identify all potential failure modes and to align them with design measures appropriate to address those modes (Klohn Crippen Berger Ltd. 2019a; Pilz 2019). The design measures are aligned with international best practice and Federal and State regulations. Resolution Copper has identified both preventative measures to minimize the potential for failure, and reactive measures if problems are seen to develop. These are considered applicant-committed environmental protection measures and are summarized in table 3.10.1-5.

Pipeline Design and Operational Measures

A failure modes analysis was also completed for both the concentrate and tailings pipelines. The analysis informed the following design measures for both the tailings and concentrate pipelines that enhance the safety of the pipelines:

- Install pipe bridges for concentrate pipeline over Queen Creek outside the ordinary high-water mark of that drainage.
- For tailings pipelines that cross Devil’s Canyon and Mineral Creek, pipeline corridors would pass beneath and outside the ordinary high-water mark.
- Fabricate and test all pipelines in corridors for concentrate, tailings, and water in accordance with the requirements of American Society of Mechanical Engineers (ASME) standards or equivalent for quality assurance and quality control purposes.
- Locate pressure indicators on non-buried pipelines intermittently along water, tailings, and concentrate pipelines. Flow indicators would be placed near the tailings pumps and at the end of the line. A leak detection system would connect via fiber-optic cable to the control room at the West Plant Site and the control room at the tailings facility if a separate facility exists.
- Pipelines would be buried where feasible, given the geological setting, and where buried they would be appropriately wrapped.

Table 3.10.1-5. Applicant-committed environmental protection measures addressing key failure modes, during both design and operations

Failure Mode	Preventative Controls	Responsive Actions (if problems develop)
Failure through foundation. Certain types of geological materials can exhibit problematic behavior due to the stress of supporting millions of tons of material, including consolidation, liquefaction, or bedding plane weaknesses.	Removal of materials (design); use of shear keys (design); thorough site investigation (design); slope flattening (design); monitoring of pore pressure and deformations (operations).	Construct berms (operations); move water pond farther from embankment (operations).
Slope failure through tailings. These failures occur when the tailings or tailings embankment loses strength, caused by increased pore pressures that reduce strength and lead to liquefaction. Failure can be triggered by either static (i.e., a gradual increase of stress as the facility grows) or seismic means.	Use of modified-centerline or centerline embankments (design); quality assurance/control during construction to confirm density requirements (operations); monitoring of pore pressure and deformations (operations); minimize perforations (pipes) through embankments (operations).	Flatten embankment slopes (operations); maintain water pond farther from embankment (operations).
Failure through internal erosion or piping. Flow developing within the embankment or foundation can wash out fine particles, gradually leading to voids and a vicious cycle of greater flow and greater washout. Controlling movement and loss of fine particles using filter materials is a key design element.	Facility beach length and structure (design); inclusion of filter materials (design); quality assurance/control during construction to confirm proper placement of materials (operations).	Placement of filters on downstream slope (operations); movement of pond away from embankment (operations); modify spigotting or tailings deposition to reduce hydraulic gradients (operations).
Failure by overtopping. When water accumulates in the pond behind the embankment and exceeds the crest height, water flowing over the top can erode the downstream face of the embankment.	Design for adequate freeboard (Probable Maximum Flood); pond storage and management requirements (design); armoring of downstream slope (design); monitoring of water levels and maintain sufficient beach width (operations).	Maintain adequate embankment freeboard (operations); construction of emergency spillways (operations); pumping (operations); emergency embankment raising (operations).
Failure through surface erosion. Erosion of material from the downstream embankment, not only by directly causing a breach, but also by causing the downstream slope to become steeper than designed.	Repair of erosion channels (operations); stormwater control (design); armoring or use of riprap (design); regular maintenance of erosion controls (operations).	Emergency repairs of eroded material (operations).

- Sacrificial anodes would be installed at determined intervals on the buried concentrate pipelines and select sections of tailings pipelines.
- Shut-off valves would be located at booster pump stations.
- Double containment would be used on the concentrate pipeline at major stream crossings and it would be routed through sleeves underneath major crossings. Tailings pipelines would be sleeved under major crossings. Expansion loops would be incorporated along the pipeline corridor.
- A minimum of 3.3 feet of horizontal and vertical separation would be used between pipelines and existing utilities or infrastructure.
- The tailings pipeline would be concrete and high-density polyethylene (HDPE) and non-pressurized for Alternatives 2 and 3, designed to flow approximately 50 percent full. The tailings pipelines to Alternatives 5 and 6 would likely be carbon steel and pressurized.
- The concentrate pipeline would be schedule 40 steel with an HDPE protective lining.
- Aboveground concentrate and tailings pipelines would be contained in a secondary containment ditch where possible and painted with an epoxy coating to prevent degradation.

In addition, a number of operational pipeline measures have been identified:

- Development of a tailings pipeline operations manual to summarize inspections and maintenance protocols (Operations, Maintenance, and Surveillance).
- Resolution Copper would have equipment available and/or contractors readily available on-site for pipeline repair. The pipeline access road would provide access to the full length of the line.
- There would be daily patrols along the pipelines to look for leaks; containment spills, sediment build-up, and breaches; drainage sediment build-up, blockages, and wash-outs; access road erosion and damage; pipe bridges and over/underpass damage; landslides; third-party interference; and other potential hazards.
- The Operations, Maintenance, and Surveillance manual would be followed for immediately investigating, reporting, and implementing a response plan for suspected leaks from the tailings pipeline. Aberrations in flow rate, pump operation, and pressures would trigger investigations and emergency response if needed.
- A tailings pipeline spill prevention and response plan (pipeline management plan) would be prepared.
- The operating concentrate pipeline would contain pressure dissipation stations consisting of control valves, block valves, and ceramic orifice plate chokes. This control system would keep the normal pipeline operating pressure below 500 psig (pounds per square inch gauge) and would lower the pressure to an acceptable level at the filter plant and loadout facility.

DESCRIPTION OF HYPOTHETICAL TAILINGS BREACH

The Forest Service requires that the tailings storage facility design, construction, and operations adhere to National Dam Safety Program standards, as well as the APP program BADCT standards. This minimizes the risk for a catastrophic failure of the tailings storage facility. Adherence by Resolution Copper to the applicant-committed environmental protection measures, including industry best practices, further reduces the risk both by proactively providing robust design and containment measures, and by identifying operational steps that can be taken in reaction to a developing problem.

However, overall risk is the combination of both the probability of a failure and the consequences of that failure. While a tailings storage facility or pipeline failure is not reasonably foreseeable, the following

Table 3.10.1-6. Empirical estimates of a hypothetical failure

Distance to:	Alternatives 2 and 3 – Near West Location*	Alternative 4 – Silver King Location (filtered)†	Alternative 5 – Peg Leg Location	Alternative 6 – Skunk Camp Location	For Comparison: Actual Mount Polley Failure‡	For Comparison: Actual Fundão Failure‡
Calculated release volume (million cubic meters)	243 (136–436)	220	243 (136–436)	243 (136–436)	23.6	45
Calculated downstream distance traveled (miles)	277 (85–901)	~1–2.5	209 (65–669)	268 (83–868)	4.4	398

Source: Larrauri and Lall (2018). Calculations can also be run at https://columbiawater.shinyapps.io/ShinyappRicoRedo/.
Note: Values shown reflect the median predicted result; values in parentheses indicate the range defined by the twenty-fifth and seventh-fifth percentiles.
Key parameters: Total facility volume at buildout = 1 billion cubic meters; Embankment height: Alt 2 (520 feet/158 m); Alt 3 (510 feet/155 m); Alt 5 (310 feet/94 m); Alt 6 (490 feet/148 m).
Mount Polley and Fundão comparisons taken from Bowker (2019).
* Alternative 3 modeled as Alternative 2
† Alternative 4 uses filtered tailings and the empirical method is not applicable. A 220 million cubic meter release was modeled using the USGS LaharZ model instead.
‡ The Mount Polley release represented 32 percent of the total facility volume; the Fundão release represented 82 percent of the total facility volume.

discussion of a hypothetical tailings storage facility or pipeline failure provides a basis to compare the inherent risk in the tailings alternative locations and designs.

Estimated Magnitude and Downstream Effect

Table 3.10.1-6 summarizes the predicted volume released in a hypothetical tailings failure, and the downstream distance traveled, based on the empirical method (Larrauri and Lall 2018; Rico et al. 2007). The downstream distance traveled would roughly represent the downstream distance to the Colorado River, near Yuma, Arizona.

The filtered tailings (Alternative 4) would likely fail in a different manner than the slurry tailings alternatives (Alternatives 2, 3, 5, and 6). As described in table 3.10.1-6, rather than running out as a liquid, the tailings would slump in a relatively localized area.

There are a number of possible failure modes for filtered tailings. Identifying the most likely failure mode relies on whether the tailings are likely to experience liquefaction. The primary factors that would trigger liquefaction of tailings are material porosity and density, moisture content, fines content, static loading (the weight of the tailings themselves), and seismic loading (earthquakes). Generally, the dewatering requirements for practical filtered operations dictate fairly low moisture content; this is necessary for handling, transporting, and placing the tailings in the storage facility. The low moisture content necessary to handle tailings physically like this (estimated for Alternative 4 as 11 to 14 percent), represents a low potential for liquefaction. A filtered tailings facility that maintains drained conditions is expected to fail as a slump or landslide (rotational or wedge shape) with no flow of tailings downstream, regardless of whether the failure is triggered by

static or seismic loading. Tailings release from a filtered tailings facility would be localized instead of flowing long distances (Witt et al. 2004).[66]

Similar to assessing the failure modes for tailings embankments for slurry tailings facilities, an FMEA could be conducted on a filtered tailings facility to assess whether undrained failure modes could occur. An undrained condition would require that a phreatic surface (i.e., water table) develop within the tailings mass itself. Under these conditions, the part of the tailings below the water table could experience liquefaction, while the part of the tailings above the water table would fail in a slump or landslide. Unlike the slurry tailings alternatives, as designed Alternative 4 would not have substantial amounts of water present and how an undrained scenario could develop is not clear. Defining a scenario under which the drainage would not occur and create a water table condition would likely require a combination of multiple factors, which could be identified during an FMEA-type of analysis.

Estimated Chemistry of Released Liquid

In the event of a failure, the materials potentially released downstream would include NPAG tailings (and associated water in the pore space), PAG tailings (and associated water in the pore space), and any standing water in the recycled water pond.

The potential effects of tailings on water quality are described in section 3.7.2 for stormwater and seepage. Water released during a potential failure would have similar characteristics, as shown in table 3.10.1-7. In the event of a release, concentrations above surface water quality standards would be anticipated for a number of metals, including cadmium, copper, nickel, selenium, silver, and zinc. Alternative 5 has the highest concentrations of cadmium, nickel, and notably copper.

Estimated Chemistry of Released Solids

The solid tailings material deposited downstream once water drains away would also pose a contamination concern. As shown in table 3.10.1-8, concentrations of metals in remnant tailings materials would be above Arizona soil remediation levels for several constituents, including arsenic and copper, and require active cleanup to prevent further degradation of groundwater or surface water.

An accidental release because of a pipeline rupture would also pose similar concerns, whether a tailings pipeline or concentrate pipeline, as shown in table 3.10.1-8.

Alternative 2 – Near West Proposed Action

TAILINGS STORAGE FACILITY DESIGN

Tailings Embankment and Facility Design

The same design and safety standards apply to any tailings embankment (see table 3.10.1-2), regardless of whether the embankment has an upstream, modified-centerline, centerline, or downstream construction. However, even though the design standards are the same, there are still inherent differences between embankment types that can factor into the long-term probability of failure.

The majority of historic events that inform our understanding of when and how tailings facilities fail were constructed using the upstream method, in which the tailings themselves form part of the structure of the embankment. When designed and operated properly, these tailings facilities can be as safe as embankments constructed using modified-centerline or centerline methods.

However, based on expert investigation of historic failures, usually a failure is the result of a chain of events that might include improper characterization of the foundation and understanding of how foundation

66. The USGS Lahar flow inundation zone simulation program (referred to as LaharZ) was used to estimate the runout zone from a potential failure of the filtered tailings (Schilling 2014). A failure angle of 10 degrees was assumed based on an estimate of the residual shear strength of the tailings in the event of saturation and/or lack of buttressing; this parameter changes with saturation levels and would change, depending on the failure modes defined in a refined FMEA.

Table 3.10.1-7. Potential for water contamination in the event of a tailings facility or pipeline failure

	Alternative 2 Released Water (mg/L)*	Alternative 3 Released Water (mg/L)*	Alternative 5 Released Water (mg/L)*	Alternative 6 Released Water (mg/L)*	Surface Water Standard for Most Restrictive Use (Gila River or Queen Creek)†	Surface Water Standard for Most Restrictive Use (Ephemeral Tributaries)†
Antimony	0.0114	0.0118	0.0056	0.0036	0.030	0.747
Arsenic	0.00092	0.00141	0.001853	0.00003	0.030	0.280
Barium	0.015	0.015	0.018	0.019	98	98
Beryllium	0.00124	0.00179	0.004552	0.00003	0.0053	1.867
Boron	0.85	0.44	0.331	0.27	1	186.667
Cadmium	0.016	0.015	0.0082	0.005	0.0043	0.2175
Chromium, Total	0.092	0.078	0.0364	0.030	1	–
Copper	0.199	0.199	4.604	0.194	0.0191	0.0669
Fluoride	2.4	2.4	3.3	2.9	140	140
Iron	0.001734	0.001727	0.008108	0.001717	1	–
Lead	0.0028	0.0021	0.00174	0.0009	0.0065	0.015
Manganese	2.23	2.23	2.182	0.63	10	130.667
Mercury	–	–	–	–	0.00001	0.005
Nickel	0.255	0.272	0.312	0.066	0.1098	10.7379
Nitrate	8.4	8.1	3.8	2.6	3,733.333	3,733.333
Nitrite	–	–	–	–	233.333	233.333
Selenium	0.346	0.349	0.149	0.113	0.002	0.033
Silver	0.079	0.073	0.030	0.026	0.0147	0.0221
Thallium	0.0058	0.0065	0.0022	0.0018	0.0072	0.075
Uranium	–	–	–	–	2.8	2.8
Zinc	3.56	3.03	1.69	1.17	0.2477	2.8758

* Results shown for all alternatives are based on predicted chemistry of "lost seepage," for year 41 representing full buildout of the facility (Eary 2018a, 2018b, 2018c, 2018d, 2018e).

Notes: Dash indicates no results available for this constituent, or no standard applies to this constituent.

Shaded cells indicate the potential for concentrations to be above water standards.

† See appendix N, table N-5, for more detail of applicable standards.

Table 3.10.1-8. Potential for contaminated material to be left in the event of a tailings facility or pipeline failure

	Copper Concentrate Material (mg/kg)*	Tailings Material (mg/kg)*	Arizona Soil Remediation Levels†
Antimony	2.2–13.3	0.18–0.71	31
Arsenic	**11.4–1,180**	**2.0–20.9**	10
Barium	20–70	120–360	15,000
Beryllium	0.05	1.62–3.53	150
Boron	–	–	16,000
Cadmium	6.56–28.1	0.09–0.24	39
Chromium, Total	28–77	36–68	120,000
Copper	**>10,000**	**781–3,288**	3,100
Fluoride	–	–	3,700
Iron	–	–	–
Lead	39.1–161.5	22–258	400
Manganese	5 - 35	20–902	3,300
Mercury	–	–	23
Nickel	32.1–71.2	17.4–45.5	1,600
Nitrate	–	–	–
Nitrite	–	–	–
Selenium	154–205	6–22	390
Silver	29–100	0.41–3.12	390
Thallium	0.17–4.57	0.29–0.82	5.2
Uranium	1–3.7	1.7–3.5	16
Zinc	1,620–5,460	17–181	23,000

Notes: Dash indicates no results available for this constituent, or no standard applies to this constituent.

Shaded cells indicate the potential for concentrations to be above soil standards.

* Tailings and concentrate material values are based on whole rock analysis performed on simulated whole tailings and concentrate for four master composites (MC-1, MC-2, MC-3, MC-4) (MWH Americas Inc. 2014).

† Arizona Administrative Code R18-7-205. Values shown represent the most stringent soil standard for both residential and non-residential property uses. Chromium standard shown is for chromium III.

conditions potentially change with tailings (as with Mount Polley), as well as operational mistakes in which the embankment construction does not adhere to the design or is managed or operated improperly (as with Fundão). The difference in embankment types is whether they are inherently resilient enough to withstand these series of unforeseen events or mistakes.

Even if embankments are designed to the same safety standards, an upstream embankment has less room for error when things do not go according to plan. A modified-centerline embankment is more resilient and has more ability to remain functional, despite any accumulated errors, and a centerline and downstream embankment have even higher resiliency.[67]

Alternative 2 would use a modified-centerline embankment, which is a design choice driven by the site geography, once the concept of an upstream embankment was abandoned (there is insufficient room at the Near West location for a full centerline embankment without expanding the footprint to another drainage). Modified-centerline embankments are inherently more resilient than upstream-type embankments, but less resilient to any accumulated missteps or unforeseen events than true centerline-type embankments.

The Alternative 2 main embankment is required to extend to three sides of the facility, is generally freestanding and not anchored to consolidated rock, and as such is the longest of the embankments proposed (10 miles). These design features are not inherently unsafe, but are potentially less resilient than a shorter, well-anchored embankment (such as Alternative 6).

Foundation Materials

The difference between foundation materials between alternatives is whether they are built primarily on consolidated rock or unconsolidated alluvium. Either type of foundation—rock or alluvium—can be appropriate for a tailings facility, provided there is adequate site characterization to identify all geological units present, understand their properties, and incorporate necessary treatment and preparation into the embankment design.

Alternative 2 is primarily built on consolidated rock, overlain by relatively thin surface soils and alluvial material along washes. Site preparation would likely involve removal of most loose material, including any weathered bedrock, and treating any problematic or weak spots in the exposed foundation. This allows better seepage control than an alluvial foundation. However, the proximity to Queen Creek downstream also limits the flexibility in adding seepage controls that can be employed in the event of unexpected seepage loss.

Storage of PAG Tailings

The method of storage of PAG tailings is another difference between alternatives that could affect outcomes associated with a failure of the facility. Alternative 2 employs a separate downstream-type starter embankment to initially contain the PAG tailings. Midway through the operational life, the PAG tailings are raised above the height of the starter embankment and therefore potentially would be released in the event of a facility failure.

A downstream embankment is one that is fully self-supporting and has no deposited tailings incorporated into the structure, though it could be composed of cyclone tailings. A downstream embankment is considered the most resilient embankment type and has more ability to remain functional, despite any accumulated errors.

67. A recent study indicates that roughly 70 percent of historic tailings failures involved upstream-type embankments, with the remainder roughly split between centerline and downstream-type embankments (Strachan and Van 2018). Note that there is inherent bias in these statistics, as the bulk of tailings structures have historically been upstream-type construction.

POTENTIAL RISK TO LIFE AND PROPERTY

The Near West location (Alternative 2) is upstream of substantial populations due to the proximity to the Phoenix metropolitan area. An estimated 600,000 people live in the communities downstream that would be affected by a hypothetical tailings storage facility failure. This location also would offer relatively little reaction time for evacuation in the event of a sudden failure, due to the close downstream presence of Queen Valley.

POTENTIAL EXPOSURE TO CONTAMINANTS

All materials released during a hypothetical tailings failure pose risk of contamination. The water present in the tailings storage facility contains concentrations of metals (cadmium, copper, nickel, selenium, silver, zinc) above Arizona surface water quality standards (see table 3.10.1-7). If released, this water would potentially impact beneficial uses of surface waters, including wildlife use, aquatic habitat, livestock use, agricultural use, and potable use. Given the highly permeable soils associated with alluvial washes like Queen Creek, released water would likely infiltrate and affect groundwater resources as well, impacting other water uses.

Similarly, the tailings material itself contains concentrations of metals (arsenic, copper) above Arizona soil remediation standards. This material would be deposited in large amounts along Queen Creek. Unless removed, the deposited tailings material would represent a long-term continuing source of contamination to groundwater and stormwater flows. The deposited tailings material could also represent a long-term hazard to public health if it became airborne during high-wind events. Wind direction is highly variable throughout the year and can include particularly intense wind events during the summer monsoon; the close proximity to the Phoenix metropolitan area would potentially expose a large population to airborne tailings.

The tailings samples have been analyzed for their long-term potential for oxidation of pyrite materials, the generation of acid, and the release of metals. While the bulk of the pyrite minerals has been segregated into the PAG tailings, both the NPAG and PAG tailings still show the potential for acid generation (see section 3.7.2). The continued oxidation of pyrite minerals in deposited tailings would represent a long-term source of impact on water quality, underlying and downstream soils, aquatic ecosystems, and the potential uses of downstream water and agricultural land.

POTENTIAL DISRUPTION OF WATER SUPPLIES AND INFRASTRUCTURE

A hypothetical tailings failure for Alternative 2 represents a substantial risk to water supplies. Eight community water systems, serving a total population of almost 700,000, were identified in the downstream flowpath. Some of these water systems have robust water portfolios and draw on different water sources, including surface water that would be unimpacted by a tailings release. All of these systems, however, use groundwater in some capacity and have pumping wells located near the downstream flowpath. The primary risk to these water systems is the potential for groundwater resources to be contaminated, or loss of water-related infrastructure.

In addition, substantial agricultural water use occurs downstream, including almost 20,000 acres in the Queen Creek Irrigation District and San Tan Irrigation District. Water supplies to agricultural users could also be disrupted through loss of wells, delivery infrastructure, or groundwater contamination.

In addition to the disruption of community water systems and agricultural supplies, a hypothetical tailings release could also destroy key water supply infrastructure. Damage to the SRP system (Consolidated Canal, Eastern Canal) or to the CAP aqueduct could disrupt water supplies throughout central and southern Arizona, well beyond the immediate flowpath of a hypothetical tailings failure. For instance, in addition to agricultural users in Pinal County, more than a dozen CAP contract holders are located downstream, with systems serving over 850,000 people. As an example, the City of Tucson relies on CAP water (mixed with groundwater) as the primary supply for over 700,000 residents.

POTENTIAL DESTRUCTION OF HABITAT AND VEGETATION

The deposition of large amounts of tailings in downstream waters would have widespread effects on the ecosystem, including riparian vegetation, wildlife habitat, and aquatic habitat. The immediate effect nearest the release would be direct physical removal or burying of vegetation from the debris. This effect would reduce with distance downstream. While woody riparian vegetation (mesquite, cottonwood, willow, saltcedar) could survive the immediate arrival of the tailings, most near-stream herbaceous and wetland vegetation would be destroyed even by a few inches of tailings.

Aquatic habitat would either physically disappear—filled with tailings—or would be rendered uninhabitable for some distance downstream by high levels of suspended sediment. After the initial impact, the geomorphology of the system would also be fundamentally altered by erosion of native material and deposition of tailings material. Expected concentrations of metals in the released water are above at least some acute wildlife standards (copper, zinc), so immediate effects on fish populations not directly lost to tailings would also be expected. Until cleanup, the tailings materials could also act as a continuing source of elevated metal concentrations.

The high-quality riparian habitat at Whitlow Ranch Dam would almost certainly be lost. Downstream of Whitlow Ranch Dam, primarily xeroriparian habitat would be lost along Queen Creek.

LARGE-SCALE SOCIETAL IMPACTS

A number of direct effects would result from a hypothetical tailings release: potential loss of life, disruptions from evacuation and relocation, destruction of property, loss of habitat, destruction or damage of infrastructure, loss or disruption of public and agricultural water supplies, disruption of regional transportation, and the long-term potential for soil, surface water, and groundwater contamination.

The large-scale societal impact of a hypothetical tailings failure is the combination of all these impacts and the fundamental disruption of a substantial portion of Arizona’s economy, the lives of a substantial portion of the population, and long-term changes to the environment.

The cost of remediation of such a release would be substantial. One research study developed a dataset of seven historical tailings failures between 1994 and 2008 for which estimates of natural resource losses could be quantified (albeit with difficulty) and found that the average natural resource loss per failure was over $500 million (in 2014 dollars) (Bowker and Chambers 2015). The size of the releases in the dataset ranged from 0.1 to 5.4 million cubic meters, much smaller than the release estimated using the empirical method.

Direct cleanup costs also can be substantial. As an example, the Mount Polley failure (23.6 million cubic meters) is estimated to have cleanup costs of roughly $67 million (Hoekstra 2014); it appears most of this cost is likely to be borne by Canadian taxpayers, not the mining company (Lavoie 2017). As another example, the mining companies involved in the Fundão failure agreed to pay over $5 billion in damages to the Brazilian government, which includes funds for remediation and restoration (Boadle and Eisenhammer 2016).

LONG-TERM IMPLICATIONS OF PRESENCE OF TAILINGS STORAGE FACILITY

The presence of a tailings storage facility on the landscape has implications for long-term potential for downstream impacts as well, even if an embankment failure never occurs. Water entrained with the tailings gradually drains from the facility over many decades. This draining is beneficial for tailings safety as it enhances stability and would continue to reduce the risk of failure. However, this seepage also causes the long-term potential for water quality impacts downstream. The long-term ramifications of seepage from tailings storage facilities is addressed in detail in Section 3.7.2, Groundwater and Surface Water Quality.

There are additional long-term impacts associated with the landform itself, including the potential for air quality impacts or windborne dust, or erosion from the tailings and subsequent sedimentation of

downstream waters. The potential for windblown dust from the tailings storage facilities is addressed in detail in Section 3.6, Air Quality, but the analysis is focused largely on operations. One assumption is that over the long term, the application and revegetation of a closure cover on the tailings facility would prevent large amounts of erosion by wind or water. The potential success of revegetation and long-term stability of the ecosystem is addressed in Section 3.3, Soils and Vegetation.

As noted, the risk of catastrophic failure decreases as water gradually drains from the facility. The duration of active seepage management after closure for Alternative 2 has been estimated as lasting up to 100 years after closure (Klohn Crippen Berger Ltd. 2018a). This represents the time period during which sufficient seepage is still being generated to require treatment or disposal, rather than relying on passive evaporation. The risk does not decrease to zero after this time period. Other failure modes still exist. This time period is being presented here solely as a proxy for how long substantial water remains in the facility for each alternative.

POTENTIAL IMPACTS FROM PIPELINES

In the event of a potential rupture, spill, or failure of either the concentrate pipeline or the tailings pipeline, the effects would be similar to those of a tailings storage facility failure with respect to direct damage to vegetation and potential for contamination. However, because of the ability to monitor and shut down the pipeline immediately upon identifying a problem, the impact would be much more localized, involve much smaller volumes, and would be of a shorter duration.

All spills associated with the concentrate pipeline and the Alternative 2 tailings pipeline would occur in ephemeral drainages and would be unlikely to move far downstream if emergency cleanup were undertaken immediately. There would likely be localized impacts on xeroriparian vegetation. Potential for impact on groundwater quality would be relatively low, given limited release volumes and limited groundwater present in these ephemeral drainages.

The total length of pipeline corridors under Alternative 2 is about 27 miles (about 22 miles for the concentrate pipeline and about 5 miles for the tailings pipelines). At closure, the risk of pipeline failure falls to zero.

FINANCIAL ASSURANCE FOR LONG-TERM MONITORING AND MAINTENANCE

Alternative 2 potentially involves long time periods of post-closure maintenance and monitoring related to ensuring the continued stability of the tailings storage facility. This raises the concern for the possibility of Resolution Copper going bankrupt or otherwise abandoning the property after operations have ceased. If this were to happen, the responsibility for these long-term activities would fall to the Forest Service. The Forest Service would need to have financial assurance in place to ensure adequate funds to undertake these activities for long periods of time—for decades or even longer.

The authority and mechanisms for ensuring long-term funding are discussed in section 1.5.5. The types of activities that would likely need to be funded could include the following:

- Monitoring of the embankment movement or stability
- Long-term control of water in the facility, such as control of stormwater entering the facility, long-term drawdown of the recycled water pond, or long-term operation of pumpback facilities
- Long-term maintenance of drains to ensure embankment stability
- Monitoring of the post-closure landform for excessive erosion or instability, and performance of any armoring
- Maintenance and monitoring of post-closure stormwater control features
- Continued implementation and periodic updating of emergency notification plans and response requirements

Additional financial assurance requirements for long-term maintenance and monitoring are part of the Arizona APP program and include the following:

> [T]he applicant or permittee shall demonstrate financial responsibility to cover the estimated costs to close the facility and, if necessary, to conduct postclosure monitoring and maintenance by providing to the director for approval a financial assurance mechanism or combination of mechanisms as prescribed in rules adopted by the director or in 40 Code of Federal Regulations section 264.143 (f)(1) and (10) as of January 1, 2014. (Arizona Revised Statutes 49-243; also see Arizona Administrative Code R18-9-A203 for specific regulations and methods allowed for financial assurance)

The Arizona State Mine Inspector also has authority to require a mine reclamation plan and financial assurance for mine closure (Arizona Administrative Code Title 11, Chapter 2). The regulations for these focus primarily on surface disturbance and revegetation.

Alternative 3 – Near West – Ultrathickened

TAILINGS STORAGE FACILITY DESIGN

While the modified-centerline embankment construction is similar between Alternatives 2 and 3, the use of ultrathickened deposition in Alternative 3 results in less water entrained in the tailings storage facility, making the facility inherently more resilient.

After the initial raises, Alternative 3 uses a splitter berm of cyclone sand to separate PAG from NPAG tailings. While this has benefits to water quality, the splitter berm would not prevent release of PAG tailings. There would be little difference in release of PAG tailings between Alternatives 2 and 3.

POTENTIAL RISK TO LIFE AND PROPERTY

The potential risks are identical to those from Alternative 2.

POTENTIAL EXPOSURE TO CONTAMINANTS

The potential risks are identical to those from Alternative 2.

POTENTIAL DISRUPTION OF WATER SUPPLIES AND INFRASTRUCTURE

The potential risks are identical to those from Alternative 2.

POTENTIAL DESTRUCTION OF HABITAT AND VEGETATION

The potential risks are identical to those from Alternative 2.

LARGE-SCALE SOCIETAL IMPACTS

The potential risks are identical to those from Alternative 2.

LONG-TERM IMPLICATIONS OF PRESENCE OF TAILINGS STORAGE FACILITY

The risk of catastrophic failure decreases as water gradually drains from the facility. Because of the use of ultrathickened tailings, the duration of active seepage management after closure for Alternative 3 has been estimated as about 9 years after closure, compared with 100 years for Alternative 2 (Klohn Crippen Berger Ltd. 2018b). This represents the time period during which sufficient seepage is still being generated to require treatment or disposal, rather than relying on passive evaporation. Risk does not decrease to zero after this time period. Other failure modes still exist. This time period is being presented here solely as a proxy for how long substantial water remains in the facility for each alternative.

POTENTIAL IMPACTS FROM PIPELINES

The potential risks are identical to those from Alternative 2.

FINANCIAL ASSURANCE FOR LONG-TERM MONITORING AND MAINTENANCE

The financial assurances are identical to those from Alternative 2.

Alternative 4 – Silver King

TAILINGS STORAGE FACILITY DESIGN

The use of filtered tailings at the Silver King location represents the least risk to public health and safety related to a catastrophic failure. Filtered tailings are fundamentally more stable than slurry facilities, and unlike the other alternatives, a failure of the filtered tailings would likely be more localized.

POTENTIAL RISK TO LIFE AND PROPERTY

The potential risk to life and property is less than the other alternatives, based on the smaller area impacted. No communities are immediately downstream of Alternative 4, within the area in which a slump or landslide failure would occur.

POTENTIAL EXPOSURE TO CONTAMINANTS

No water would be potentially released during a catastrophic failure of Alternative 4, and exposure to contaminants would be primarily related to the long-term exposure of solid material in washes, including erosion and movement downstream, and leaching of contaminants. The filtered materials are estimated to have more potential for water quality impacts, due to the chemical weathering from the ingress of oxygen into the pore space. The PAG tailings, in particular, if deposited in washes, would represent a long-term risk to water quality if not removed.

POTENTIAL DISRUPTION OF WATER SUPPLIES AND INFRASTRUCTURE

The potential disruption of water supplies and infrastructure is less than the other alternatives, based on the smaller area impacted.

POTENTIAL DESTRUCTION OF HABITAT AND VEGETATION

The potential destruction of habitat and vegetation is less than the other alternatives, based on the smaller area impacted. In addition, primarily xeroriparian habitat along ephemeral washes would be impacted, rather than perennial waters and hydroriparian and aquatic habitat.

LARGE-SCALE SOCIETAL IMPACTS

The large-scale societal impact of a failure at Alternative 4 is less than the other alternatives, based on the smaller area impacted.

LONG-TERM IMPLICATIONS OF PRESENCE OF TAILINGS STORAGE FACILITY

The risk of catastrophic failure decreases as water gradually drains from the facility. As there is relatively little seepage associated with Alternative 4, the amount of time for active seepage management after closure is only 5 years, compared with 100 years for Alternative 2 (Klohn Crippen Berger Ltd. 2018c). This represents the time period during which sufficient seepage is still being generated to require treatment or disposal, rather than relying on passive evaporation. Risk does not decrease to zero after this time period. Other failure modes still exist. This time period is being presented here solely as a proxy for how long substantial water remains in the facility for each alternative.

POTENTIAL IMPACTS FROM PIPELINES

Alternative 4 still requires concentrate and tailings pipelines; however, the overall distance is substantially less, and would represent less risk

overall. The total length of pipeline corridors under Alternative 4 is less than 2 miles (there is no concentrate pipeline, and about 1.5 miles for the tailings pipelines). At closure, the risk of pipeline failure falls to zero.

FINANCIAL ASSURANCE FOR LONG-TERM MONITORING AND MAINTENANCE

The regulatory framework to require financial assurance to ensure closure and post-closure activities are conducted is the same as for Alternative 2.

Alternative 5 – Peg Leg

TAILINGS STORAGE FACILITY DESIGN

Tailings Embankment and Facility Design

Alternative 5 uses a centerline-type NPAG embankment, representing a more resilient design than Alternatives 2 and 3. Like Alternatives 2 and 3, the main embankment is a side hill embankment that extends on three sides of the facility and is generally freestanding and founded on alluvium versus bedrock, which is inherently less resilient than Alternative 6. The length of the embankment (7 miles) is slightly shorter than Alternatives 2 and 3. The PAG embankments use downstream construction to maintain a water cover over the PAG tailings. The PAG embankments are divided into cells to minimize seepage, reduce evaporation, and allow concurrent reclamation during operations.

Foundation Materials

The main NPAG embankment for Alternative 5 would be primarily underlain by thick unconsolidated alluvium, with some bedrock occurring below the PAG cells. Detailed site characterization through drilling and excavation would be used to understand the specific properties of the alluvial material beneath the main embankment and develop a design to address any stability concerns. Seepage may be more difficult to control with Alternative 5, as losses to an alluvial foundation are substantial and the downstream alluvial aquifer is relatively wide.

Storage of PAG Tailings

Unlike Alternatives 2 and 3, Alternative 5 uses an entirely separate PAG tailings facility with a downstream embankment to contain the PAG tailings throughout the life of the facility. In addition, the PAG tailings facility is divided into cells to reduce evaporation and seepage and allow concurrent reclamation. In the event of a failure of the NPAG main embankment, the double embankment of Alternative 5 means that PAG tailings would not be released unless both the NPAG and PAG embankments failed simultaneously. Alternatively, if one of the PAG cells failed, the runout could be contained within the NPAG facility.

POTENTIAL RISK TO LIFE AND PROPERTY

The Peg Leg location is upstream of populations in Pinal County and the Gila River Indian Community. An estimated 32,000 people live in the communities downstream that could be affected by a hypothetical tailings storage facility failure. This location would offer some improvement in reaction time over Alternatives 2 and 3 for evacuation in the event of a sudden failure, with no major population centers downstream for roughly 20 miles. The Peg Leg location offers the greatest risk to the town of Florence and the Gila River Indian Community.

POTENTIAL EXPOSURE TO CONTAMINANTS

As with Alternatives 2 and 3, all materials released during a hypothetical tailings failure pose risk of contamination, with metal concentrations in water and tailings material above Arizona standards. The risks to beneficial uses of surface waters, groundwater, and public health are similar, though receptors would differ.

POTENTIAL DISRUPTION OF WATER SUPPLIES AND INFRASTRUCTURE

A hypothetical tailings failure for Alternative 5 represents a substantial risk to water supplies. Four community water systems, serving a total population of almost 30,000, were identified in the downstream flowpath. Unlike the community water systems downstream of Alternatives 2 and 3, which have robust water portfolios, most of these systems are highly reliant on groundwater and most have wells directly adjacent to the Gila River. The primary risk to these water systems is the potential for groundwater resources to be contaminated, or loss of water-related infrastructure. The town of Florence has one of the closest water systems, serving roughly 15,000 people and relying on groundwater wells immediately adjacent to the Gila River.

The disruption of agricultural water supplies would have a substantial effect on Pinal County and the Gila River Indian Community. The Pinal County economy relies heavily on agriculture and is one of the most important agricultural areas in the United States. Pinal County is in the top 2 percent of counties in the United States for total agricultural sales (Bickel et al. 2018) and has more than 230,000 acres under irrigation (National Agricultural Statistics Service 2014). The New Magma Irrigation and Drainage District and the San Carlos Irrigation and Drainage District both lie largely within Pinal County and account for about a third of agricultural acreage. A potential tailings release could affect water supplies for the roughly 77,000 acres within these districts, through destruction of infrastructure, contamination of surface supplies from the Gila River, or contamination of groundwater sources below the Gila River.

The total contribution of on-farm agriculture to Pinal County sales was an estimated $1.1 billion in 2016, supporting over 7,500 full- and part-time employees (Bickel et al. 2018). Bickel et al. (2018) also estimated the effect of a hypothetical loss of 300,000 acre-feet of irrigation water and found there would be an economic impact of up to $35 million, with up to 480 job losses. This hypothetical reduction represents about a one-third reduction in total water use of 800,000 acre-feet (Water Resources Research Center 2018).

The Gila River Indian Community is also reliant on agriculture, with about 27,000 acres irrigated (National Agricultural Statistics Service 2014), and a total market value of agricultural products sold of $38.4 million (Duval et al. 2018). Increased agriculture is the centerpiece of Gila River Indian Community economic growth, through the continued construction of the Pima-Maricopa Irrigation Project, which is meant to use water provided under the Arizona Water Settlements Act of 2004. The Community intends to increase agricultural production to over 140,000 acres of irrigable land. Water sources potentially disrupted by a hypothetical tailings release include supplies from the Gila River, groundwater, and water stored in underground recharge projects.

POTENTIAL DESTRUCTION OF HABITAT AND VEGETATION

The potential destruction of habitat and vegetation for Alternative 5 is similar to Alternative 2, except the impacts would be borne by the Gila River, which has existing aquatic habitat as well as critical habitat and proposed critical habitat. The wetlands downstream on the Gila River Indian Community could also be impacted.

The modeled water quality results in table 3.10.1-7 suggest that Alternative 5 might have substantially higher dissolved metals, particularly copper, and would represent a greater risk of acute toxicity to aquatic wildlife in downstream waters not directly inundated by tailings.

LARGE-SCALE SOCIETAL IMPACTS

The societal impacts for Alternative 5 are similar to those discussed for Alternative 2. In addition, a hypothetical release from Alternative 5 could impact the town of Florence as well as the Gila River Indian Community. The Gila River Indian Community has a greater than 40 percent poverty rate, with a median household income about one-third of the national median (U.S. Census Bureau 2018). The population of the areas downstream of Alternative 5 (3,655) represent roughly 30 percent of the total Community population (U.S. Census Bureau 2018).

The impact of a hypothetical tailings release would be much more pronounced on the Gila River Indian Community, and the ability to recover would be much less than other communities.

LONG-TERM IMPLICATIONS OF PRESENCE OF TAILINGS STORAGE FACILITY

Alternative 5 has similar long-term implications for air quality, revegetation success, and groundwater quality, as those described for Alternative 2, with differences noted in the specific EIS sections referenced.

As noted, the risk of catastrophic failure decreases as water gradually drains from the facility. The duration of active seepage management after closure for Alternative 5 has been estimated to be up to 100 to 150 years after closure, similar to Alternative 2 (Golder Associates Inc. 2018b). This represents the time period during which sufficient seepage is still being generated to require treatment or disposal, rather than relying on passive evaporation. Risk does not decrease to zero after this time period. Other failure modes still exist. This time period is being presented here solely as a proxy for how long substantial water remains in the facility for each alternative.

POTENTIAL IMPACTS FROM PIPELINES

For the ephemeral drainages crossed by either the west or east pipeline option for Alternative 5, the impacts from a pipeline failure would be identical to Alternative 2. However, both the west and east pipeline options also cross the Gila River, which represents a high-value riparian area that could be impacted in the event of a failure. In this case, the impacts would be similar to those described for a tailings storage facility runout reaching the Gila River, but more localized. The Alternative 5 east option also carries more risk for downstream habitat in Arnett Creek and Queen Creek by paralleling that water body for several miles and has a risk for destruction of downstream habitat associated with the Walnut Canyon ACEC.

The total length of pipeline corridors under Alternative 5 is about 47 miles (about 22 miles for the concentrate pipeline, and about 25 miles for the tailings pipelines). At closure, the risk of pipeline failure falls to zero.

FINANCIAL ASSURANCE FOR LONG-TERM MONITORING AND MAINTENANCE

The regulatory framework under the State of Arizona to require financial assurance for long-term closure activities is the same as described for Alternative 2. However, for the tailings facility, financial assurance requirements would be required by the BLM, not the Forest Service.

Like the Forest Service, the BLM also has regulatory authority to require financial assurance for closure activities, contained in their surface management regulations (43 CFR Subpart 3809). BLM considers that the financial assurance must cover the estimated cost as if BLM were hiring a third-party contractor to perform reclamation of an operation after the mine has been abandoned. The financial assurance must include construction and maintenance costs for any treatment facilities necessary to meet Federal and State environmental standards.

Alternative 6 – Skunk Camp

TAILINGS STORAGE FACILITY DESIGN

Tailings Embankment and Facility Design

Like Alternative 5, Alternative 6 uses a true centerline-type embankment, representing a more resilient design than Alternatives 2 and 3. The embankment design for Alternative 6 is substantially different from the other alternatives. This embankment uses a cross-valley construction, which would have a single face instead of three faces and would be tied into consolidated rock on either end. This construction results in a shorter face, only requiring 3 linear miles of embankment. As with the embankment type, all embankments would be designed to the same safety standards, but the simpler construction of the Alternative

6 embankment could be considered more resilient to any accumulated missteps or unforeseen events.

Foundation Materials

Alternative 6 is similar to Alternatives 2 and 3 and would be primarily underlain by unconsolidated alluvium within drainages and a thick sequence of Gila Conglomerate bedrock. Below the PAG facility, which is farthest away from the NPAG embankment, alluvium is less, and the primary subsurface material is Gila Conglomerate. Compared with Alternative 5, seepage is easier to control, with much of the facility underlain by bedrock rather than alluvium. In addition, the downstream alluvial aquifer is narrow and any downstream seepage controls would likely be more effective than at Alternative 5.

Storage of PAG Tailings

Like Alternative 5, Alternative 6 uses an entirely separate PAG tailings cell with a downstream-type embankment that would contain the PAG tailings throughout the life of the facility. In addition, the PAG tailings are divided and stored in entirely separate cells. Because of this double embankment within one impoundment, with Alternative 6, PAG tailings would be less likely to be released, and individual cells would limit the amount of PAG tailings released.

POTENTIAL RISK TO LIFE AND PROPERTY

Like Alternative 5, the Skunk Camp location is upstream of populations in Pinal County. Approximately 3,000 people live in the communities downstream that would be affected by a hypothetical tailings storage facility failure. This location also would offer some improvement in reaction time over Alternatives 2 and 3 for evacuation in the event of a sudden failure, with the major towns (Hayden, Kearny, Winkelman) located over 20 miles downstream, but the nearest population center (Dripping Springs) is still within 10 miles of the facility.

Alternative 6 offers less risk to the town of Florence and Gila River Indian Community than Alternative 5, as these communities are over 50 miles distant from the tailings location.

POTENTIAL EXPOSURE TO CONTAMINANTS

As with Alternatives 2, 3, 4, and 5, all materials released during a hypothetical tailings failure pose risk of contamination, with metal concentrations in water and tailings material above Arizona standards. The risks to beneficial uses of surface waters, groundwater, and public health are similar, though receptors would differ.

POTENTIAL DISRUPTION OF WATER SUPPLIES AND INFRASTRUCTURE

A hypothetical tailings failure for Alternative 6 represents a risk to water supplies. Four community water systems are located along the Gila River above Donnelly Wash, serving approximately 3,000 people. These systems are entirely reliant on groundwater and most have wells directly adjacent to the Gila River. The primary risk to these water systems is the potential for groundwater resources to be contaminated, or loss of infrastructure.

The potential disruption of agricultural water supplies would be less than those described for Alternative 5.

POTENTIAL DESTRUCTION OF HABITAT AND VEGETATION

The potential destruction of habitat and vegetation for Alternative 6 is similar to Alternative 5, but somewhat less due to the greater distance between Alternative 6 and the Gila River, compared with Alternative 5 and the Gila River. Alternative 6 carries a risk of potential destruction of habitat and vegetation associated with the area identified by BLM as suitable for the National Rivers System, between Dripping Springs and Winkelman, including the loss of recreation opportunities along this corridor.

LARGE-SCALE SOCIETAL IMPACTS

The societal impacts for Alternative 6 are similar to those discussed for Alternative 5, but the impacts would be felt mainly in the communities of Kearny, Hayden, and Winkelman, located along the Gila River. These are small communities directly adjacent to the river, heavily dependent on the local water supply. The economic impact from property loss, business disruption, and destruction of local infrastructure would affect every aspect of these communities.

LONG-TERM IMPLICATIONS OF PRESENCE OF TAILINGS STORAGE FACILITY

Alternative 6 has similar long-term implications for air quality, revegetation success, and groundwater quality, as those described for Alternative 2, with differences noted in the specific EIS sections referenced.

As noted, the risk of catastrophic failure decreases as water gradually drains from the facility. The duration of active seepage management after closure for Alternative 6 has been estimated to be up to 20 years after closure (Klohn Crippen Berger Ltd. 2018d). This represents the time period during which sufficient seepage is still being generated to require treatment or disposal, rather than relying on passive evaporation. Risk does not decrease to zero after this time period. Other failure modes still exist. This time period is being presented here solely as a proxy for how long substantial water remains in the facility for each alternative.

POTENTIAL IMPACTS FROM PIPELINES

For the ephemeral drainages crossed by either the north or south pipeline option for Alternative 6, the impacts from a pipeline failure would be identical to Alternative 2. However, both the north and south pipeline routes have to cross Devil's Canyon and also parallel Mineral Creek, increasing the risk of adverse consequences to those perennial waters in the event of a failure. While the north route option would cross Devil's Canyon farther upstream and away from perennial flow, a failure at either crossing location would have the potential to affect the water, aquatic, and riparian habitat downstream.

Similar to the Alternative 5 east route, the south option for Alternative 6 carries more risk for downstream habitat in Arnett Creek and Queen Creek by paralleling that water body for several miles.

The total length of pipeline corridors under Alternative 6 is about 47 miles (about 22 miles for the concentrate pipeline, and about 25 miles for the tailings pipelines). At closure, the risk of pipeline failure falls to zero.

FINANCIAL ASSURANCE FOR LONG-TERM MONITORING AND MAINTENANCE

The regulatory framework under the State of Arizona to require financial assurance for long-term closure activities is the same as described for Alternative 2. However, Alternative 6 differs from the other alternatives because the tailings facility would not be located on lands managed by the Forest Service (Alternatives 2, 3, and 4) or BLM (Alternative 5). For Alternative 6, the Federal financial assurance mechanisms would not be applicable.

Overall Conclusions of Potential Risk to Public Health and Safety

The Forest Service requirement for the tailings storage facility design, construction, and operation to adhere to National Dam Safety Program standards, as well as APP BADCT standards, minimizes the risk for a catastrophic failure of the tailings storage facility. Adherence by Resolution Copper to the applicant-committed environmental protection measures, including industry best practices, further reduces the risk both by proactively providing a robust design and containment measures, and by identifying operational steps that can be taken in reaction to a developing problem.

There are some qualitative differences in alternatives that are inherent in the design and location of each alternative that affect the resilience of

the facility, as shown in table 3.10.1-9. There are also differences in the downstream environment.

Cumulative Effects

The Tonto National Forest identified the following reasonably foreseeable future actions as likely, in conjunction with development of the Resolution Copper Mine, to contribute to cumulative impacts on geology, minerals, and subsidence. However, it should be noted that no other mining or other human activities in the cumulative impact assessment area were identified as likely to result in geological subsidence. The analysis here therefore focuses on effects on area geology and mineral resources. As noted in section 3.1, past and present actions are assessed as part of the affected environment; this section analyzes the effects of any RFFAs, to be considered cumulatively along with the affected environment and Resolution Copper Project effects.

- *Pinto Valley Mine Expansion.* The Pinto Valley Mine is an existing open-pit copper and molybdenum mine located approximately 8 miles west of Miami, Arizona, in Gila County. Pinto Valley Mining Corporation is proposing to expand mining activities onto an estimated 1,011 acres of new disturbance (245 acres on Tonto National Forest land and 766 acres on private land owned by Pinto Valley Mining Corporation) and extend the life of the mine to 2039. The company estimates average annual copper production rates of between 125 and 160 million pounds to continue through the extended operational life of this mine. This facility has a tailings impoundment, which is being expanded, and has had tailings failures in the past. However, the area potentially impacted downstream is in a different watershed than any of the Resolution Copper Project alternatives and would not contribute cumulatively to the overall risk to public safety.
- *Ripsey Wash Tailings Project.* ASARCO is planning to construct a new tailings storage facility to support its Ray Mine operations. The environmental effects of the project were analyzed in an EIS conducted by the USACE and approved in a ROD issued in December 2018. As approved, the proposed tailings storage facility project would occupy an estimated 2,574 acres and be situated in the Ripsey Wash watershed just south of the Gila River approximately 5 miles west-northwest of Kearny, Arizona, and would contain up to approximately 750 million tons of material (tailings and embankment material). ASARCO estimates a construction period of 3 years and approximately 50 years of expansion of the footprint of the tailings storage facility as slurry tailings are added to the facility, followed by a 7- to 10-year period for reclamation and final closure. The Ripsey Wash facility is very near on the landscape to Alternative 5 – Peg Leg, and the same downstream communities would be impacted in the event of a failure. This represents a cumulative impact on the overall risk to public safety, in combination with the Resolution Copper Project, in the event Alternative 5 or 6 is selected.
- *Ray Land Exchange and Proposed Plan Amendment.* ASARCO is also seeking to complete a land exchange with the BLM by which the mining company would gain title to approximately 10,976 acres of public lands and federally owned mineral estate located near ASARCO's Ray Mine in exchange for transferring to the BLM approximately 7,304 acres of private lands, primarily in northwestern Arizona. It is known that at some point ASARCO wishes to develop a copper mining operation in the "Copper Butte" area west of the Ray Mine; however, no specific details are currently available as to potential environmental effects resulting from this future mining operation. While this area would be used for mining, it is believed that existing ASARCO tailings facilities (including Ripsey Wash) would be the likely recipient of tailings. In this case, this project would not contribute cumulatively to the overall risk to public safety.
- *ASARCO Mine, including the Hayden Concentrator and Smelter.* The Ray Operations consists of a 250,000 ton/day open-pit mine with a 30,000 ton/day concentrator, a 103 million

Table 3.10.1-9. Differences between alternatives pertinent to tailings and pipeline safety

	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6
Embankment type	Modified centerline	Modified centerline	Filtered tailings; structural zone, but no embankment. Most resilient alternative.	True centerline. Improved resilience, compared with Alternatives 2 and 3.	True centerline Improved resilience, compared with Alternatives 2 and 3.
Embankment size and design	Freestanding; 10-mile length	Freestanding; 10-mile length	No embankment	Freestanding; 7-mile length	Cross-valley construction; 3-mile length. Improved resilience, compared with Alternatives 2, 3, and 5.
Potential for PAG release	PAG deposition inside NPAG facility, no separate embankment (at buildout)	PAG deposition inside NPAG facility, no separate embankment (at buildout)	Separate PAG facility. Downstream risk for PAG release less, due to localized failure.	Separate PAG facility; multiple cells; separate downstream embankment. Less risk for release of PAG tailings during catastrophic failure than Alternatives 2 and 3.	Separate PAG facility; multiple cells; separate downstream embankment. Less risk for release of PAG tailings during catastrophic failure than Alternatives 2 and 3.
Downstream population (within 50 miles)	600,000	600,000	700	32,000	3,200
Nearest population	Within 10 miles	Within 10 miles	Within 10 miles	Over 20 miles	Within 10 miles
Pipeline risk	Ephemeral drainages; relatively low risk	Ephemeral drainages; relatively low risk	Ephemeral drainages; relatively low risk	West option: Higher risk at crossings of Queen Creek, Gila River, and parallel of Reymert Wash East option: Higher risk from crossings of Queen Creek, Gila River, and parallel of Arnett Creek	North option: Higher risk at crossings of Devil's Canyon and parallel of Mineral Creek South option: Higher risk at crossings of Queen Creek, Devil's Canyon, and parallel of Mineral Creek
Miles of pipeline	Concentrate = 22 Tailings = 5	Concentrate = 22 Tailings = 5	Concentrate = 0 Tailings = 1.5	Concentrate = 22 Tailings = 25	Concentrate = 22 Tailings = 25
Anticipated risk period for pipelines	41 years. LOM only. Risk ends upon closure	41 years. LOM only. Risk ends upon closure	41 years. LOM only. Risk ends upon closure	41 years. LOM only. Risk ends upon closure	41 years. LOM only. Risk ends upon closure
Anticipated risk period for tailings storage facilities*	150 years (LOM, plus estimated seepage for ~100 years post-closure)	50 years (LOM, plus estimated seepage for ~9 years post-closure)	45–50 years (LOM, plus estimated seepage for ~5 years post-closure)	150–200 years (LOM, plus estimated seepage or 100–150 years post-closure)	70 years (LOM, plus estimated seepage for 20 years post-closure)

LOM = Life of mine

* The estimate shown here is the life of mine, plus the length of time active seepage management is anticipated to take after closure (see section 3.7.2). This is being presented as a proxy for risk, only to highlight differences in the period of drain-down between alternatives. A number of failure modes continue to be possible after active seepage management has been discontinued.

pounds/year solvent extraction-electrowinning operation, and associated maintenance, warehouse, and administrative facilities. Cathode copper produced in the solvent extraction and electrowinning operation is shipped to outside customers and to the ASARCO Amarillo Copper Refinery. A local railroad, Copper Basin Railway, transports ore from the mine to the Hayden concentrator, concentrate from the Ray concentrator to the smelter, and sulfuric acid from the smelter to the leaching facilities.

- The ASARCO Hayden Plant Superfund site is located 100 miles southeast of Phoenix and consists of the towns of Hayden and Winkelman and nearby industrial areas, including the ASARCO smelter, concentrator, former Kennecott smelter and all associated tailings facilities in the area surrounding the confluence of the Gila and San Pedro Rivers. These tailings facilities are smaller than the planned Ripsey Wash or Resolution Copper Project tailings facilities but are near the Gila River and upstream of the same communities and ecosystems. These tailings facilities, though already on the landscape and not expanding, still represent a cumulative risk to overall public safety, in combination with the Resolution Copper Project, in the event Alternatives 5 or 6 are selected.

Two other large-scale mining operations in cumulative assessment area, Freeport-McMoRan's Miami Inspiration Mine and KGHM's Carlota Mine, are nearing the end of their effective mine life and are limiting current and future mineral extraction activities to leaching of existing rock stockpiles. The facilities would be in a different watershed, they would not be expanding their tailings facilities, and they do not contribute cumulatively to the risk to public safety. It is reasonable to assume that during the projected life of the Resolution Copper Mine (50–55 years), other tailings facilities would be developed in association with the widespread mining activity in the Copper Triangle and within the cumulative effects analysis area.

Mitigation Effectiveness

The Forest Service is in the process of developing a robust mitigation plan to avoid, minimize, rectify, reduce, or compensate for resource impacts that have been identified during the process of preparing this EIS. Appendix J contains descriptions of mitigation concepts being considered and known to be effective, as of publication of the DEIS. Appendix J also contains descriptions of monitoring that would be needed to identify potential impacts and mitigation effectiveness. As noted in chapter 2 (section 2.3), the full suite of mitigation would be contained in the FEIS, required by the ROD, and ultimately included in the final GPO approved by the Forest Service. Public comment on the DEIS, and in particular appendix J, will inform the final suite of mitigations.

This section contains an assessment of the effectiveness of design features from the GPO and mitigation and monitoring measures found in appendix J that are applicable to tailings safety.

MITIGATION MEASURES APPLICABLE TO TAILINGS AND PIPELINE SAFETY

Satellite Monitoring of Tailings Storage Facility (FS-01): High-resolution satellite imagery would be collected and processed at regular intervals. Processed output provided to the Forest Service or BLM would include beach width, tailings surface slope contours, and constructed site topography. This output could be provided for land manager verification of adherence to design criteria, as well as long-term monitoring of facility performance over time. This measure would be applicable to Alternatives 2, 3, 4, and 5 through 36 CFR 228.8 (Forest Service authority to regulate mining to minimize adverse environmental impacts on NFS surface resources) and 43 CFR 3809.2 (BLM authority to regulate mining to prevent unnecessary or undue degradation). This measure primarily focuses on tailings safety, which in turn is protective of human life, property, and numerous downstream resources.

Improve Resiliency of Tailings Storage Facility (GP-26). Some recommended mitigation measures regarding the tailings storage

facility, to include where appropriate, are the use of a liner, constructing a secondary backup containment facility, developing a mitigation plan for tailings storage facility embankment breach, implementing a cease operation plan in the event of a tailings embankment failure, requiring an environmental damage assessment in the event of a tailings embankment release, and identifying alternative energy sources for the tailings storage facility in the event of an electrical outage. These measures would be applicable to all alternatives, noted in the ROD/Final Mining Plan of Operations, and required by the Forest Service. No additional ground disturbance would be required.

Conduct Refined FMEA before FEIS (FS-227): The failure modes analysis conducted by Resolution Copper is based on the DEIS alternative design documents. With more refined designs and site-specific information, a more robust and refined FMEA can be conducted. The Forest Service is requiring that this refined FMEA be conducted between the DEIS and FEIS. This exercise will inform the requirements to be specified in the ROD and ultimately incorporated into a final plan of operations.

The refined FMEA would be a collaborative group process that would be led by the Forest Service. It is likely to include Forest Service personnel, cooperating agency representatives, Resolution Copper and their tailings experts and contractors, and the NEPA team and their tailings experts. This group would identify possible failure modes, their likelihood of occurring, the level of confidence in the predictions, the severity of the consequences if that failure mode were to occur, and possible controls to reduce the risk of failure. The collaborative group would likely also be asked to identify a reasonable failure scenario to use in a refined breach analysis.

During an FMEA, the tailings storage facility is considered as a complete system with a number of components, including geology, foundation, engineered structures, seepage controls, drains, containment, diversions, and spillways. Sufficient information on the design and specifications of each component is needed in order to understand how the components would function as a system, and how they might respond to the anticipated stresses on the system. The information needed to support a collaborative, refined FMEA would include the results of site investigations (geology and foundation), lab testing, engineering analyses, borrow material analyses and specifications, and engineered drawings and specifications. The less information available during the FMEA process, the more assumptions have to be made, leading to a less meaningful assessment that may not be representative of the true risks for the ultimate designed facility.

Adherence to National Dam Safety Program Standard (FS-228): For a tailings storage facility built on Federal land, the Forest Service is requiring that Resolution Copper adhere, at a minimum, to the requirements of the National Dam Safety Program discussed in “Relevant Laws, Regulations, Policies, and Plans” in section 3.10.1.3.

Development of an Emergency Action Plan for the Tailings Storage Facility (FS-229): For a tailings storage facility built on Federal land, the Forest Service is requiring that Resolution Copper undertake Emergency Action Planning, as required under the National Dam Safety Program (Federal Emergency Management Agency 2004). The FMEA would provide key information to this process. Emergency Action Planning would include evaluation of emergency potential, inundation mapping and classification of downstream inundated areas, response times, notification plans, evacuation plans, and plans for actions upon discovery of a potentially unsafe condition.

The breach analysis prepared for the DEIS is not sufficient to meet National Dam Safety Standards for emergency planning. The Forest Service will require a refined breach analysis be conducted between the DEIS and FEIS, using appropriate models, based on the outcome of the FMEA and a selected failure scenario.

MITIGATION EFFECTIVENESS AND IMPACTS

Adherence to National Dam Safety Program standards, incorporating additional features to enhance resiliency, and conducting an FMEA between the DEIS and FEIS all would help reduce or minimize the inherent risk from a tailings storage facility by ensuring that the design is appropriate and robust, and addresses possible failure modes.

Conducting satellite monitoring would provide a means of independently detecting deviations from operational plans and enhance the ability of Federal agencies to provide meaningful oversight; this would reduce the inherent risk from a tailings storage facility.

Development of an emergency action plan would not reduce the risk of failure but would reduce the potential consequences in the event of a failure.

UNAVOIDABLE ADVERSE IMPACTS

The mine and associated activities are expected to increase risks to public health and safety from the presence of a large tailings storage facility on the landscape, and the transport of concentrate and tailings by pipeline. These risks are unavoidable. However, risk of failure is minimized by required adherence to National Dam Safety Program and APP program standards, applicant-committed environmental protection measures, and the mitigation measures described here.

Other Required Disclosures

SHORT-TERM USES AND LONG-TERM PRODUCTIVITY

Impacts from risk associated with tailings embankment safety would exist for a long time on the landscape and may result in some land uses downstream of the facility being curtailed. Over time, the reduction of risk would diminish, and productivity of downstream areas would recover.

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

Irreversible changes with respect to tailings safety are not expected. The risk from pipeline failures ends upon closure of the mine and would be considered irretrievable but not irreversible. The risk from a tailings facility would persist for decades but would diminish as the structure drains. Impacts on public safety from tailings or tailings and concentrate pipelines would constitute an irretrievable commitment of resources.

3.10.2 Fuels and Fire Management

3.10.2.1 Introduction

This section assesses fuels and fire management both in the project area and within the larger analysis area (figure 3.10.2-1). Fuel means any vegetation, including grass, shrubs, and trees, that could sustain a wildfire. "Fuels and fire management" refers to the ability of land managers and emergency responders to maintain fuel levels and conduct other activities to prevent wildfires or control their extent or severity. Mine operations would include activities that would change fuel loads in the area or increase the possibility of accidental ignition of a wildfire, which would result in increased risk of fire and would change the severity and extent of fires that could occur. This section discusses the vegetation communities present, fire history and fire management, wildfire-urban interfaces (WUIs), and changes in wildfire risk resulting from the proposed project.

3.10.2.2 Analysis Methodology, Assumptions, and Uncertain and Unknown Information

Analysis Area

The analysis area for considering direct and indirect effects on fuels and fire management includes all proposed mine components, the four alternative tailings storage facility locations, and mine-related linear facilities such as pipelines, power lines, and roads. This area includes all lands where mine-related activities would increase fuel accumulations as a result of subsidence or increase the risk of inadvertent, human-caused fire ignitions that could spread to and impact adjacent NFS, BLM, State Trust, and private lands, as well as lands within the Pinal County "*Community Wildfire Protection Plan*" (CWPP)-designated WUI. This analysis area is depicted in figure 3.10.2-2. The temporal extent of analysis for fuels and fire management includes the construction, operations, and closure and reclamation phases of the proposed project.

Methodology

Analysts assess impacts associated with both fuel loading and fire risk qualitatively based on the types and locations of mining activities. Specific mine activities that analysts considered include blasting, increased vehicle traffic, storage and transportation of flammable materials, fuel loading from clearing of vegetation, impacts on vegetation from water use, introduction of noxious weeds, construction activities, and reduction in recreational use. Fuels and fire data (e.g., fire behavior-based fuel classifications, vegetation community-based fire regime information, local fire history, and jurisdictional wildfire response strategies) were compiled to identify where and when changes in wildfire risk are most likely to occur as a result of implementing the proposed project.

The available resources to analyze fuels and fire management impacts were adequate; no uncertain or unknown information has been identified.

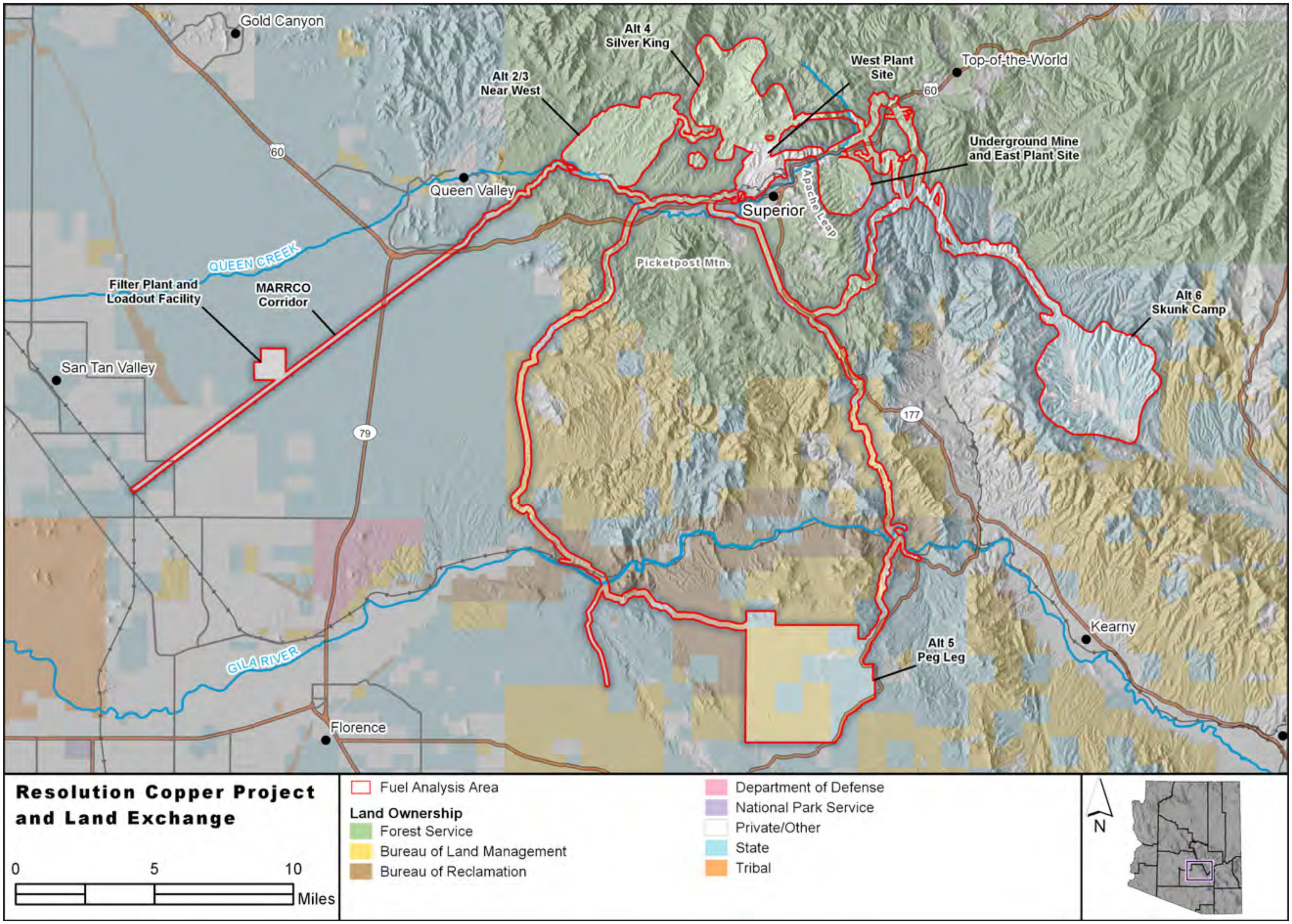


Figure 3.10.2-1. Fuels and fire management analysis area

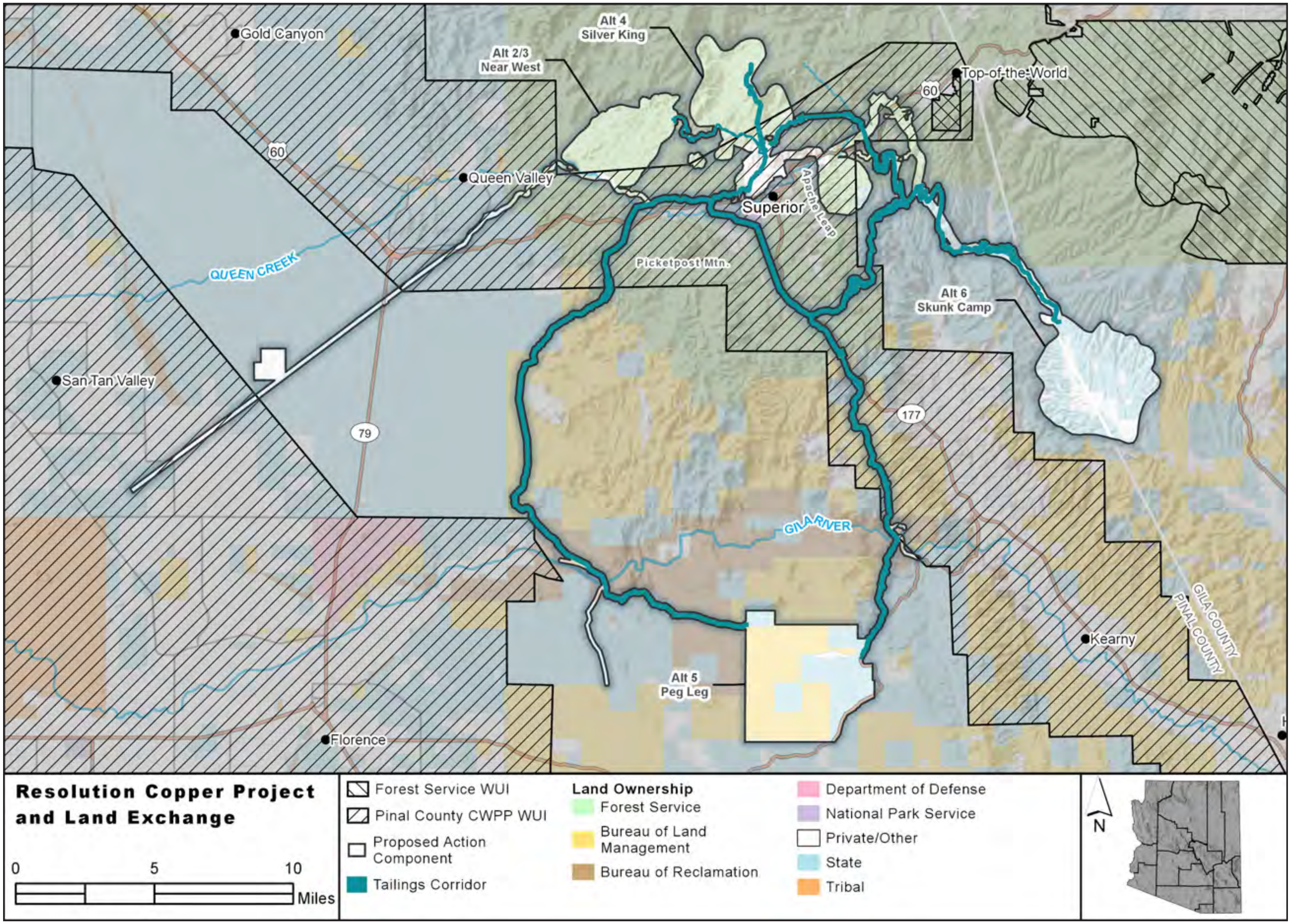


Figure 3.10.2-2. Wildland-urban interface delineation for the project area, comprising Forest Service–delineated and Pinal County CWPP–delineated WUI

3.10.2.3 Affected Environment

Relevant Laws, Regulations, Policies, and Plans

The legal authorities guiding this analysis of the effects of change on fuels and fire management as a result of the project, along with the alternatives identified in the EIS, are shown in the accompanying text box. A complete listing and brief description of the laws, regulations, reference documents, and agency guidance used in this fuels and fire management effects analysis may be reviewed in Newell and Garrett (2018b).

Primary Legal Authorities Relevant to the Fuels and Fire Management Effects Analysis

- Federal Wildland Fire Policy of 1995
- National Fire Plan (2001), including the Healthy Forest Restoration Act and the Healthy Forest Initiative
- Tonto National Forest Land and Resource Management Plan

Existing Conditions and Ongoing Trends

FUEL CLASSIFICATION

Fuel is the term given to vegetation that is available for combustion. Fuels generally belong to three categories: grass, shrubs, and timber.

Modeling fire behavior requires an additional breakdown of fuel characteristics: fuel-bed depth, surface area-to-volume ratio, and the amount of fuel loading in a given area. Surface fuels include litter, duff, and coarse woody debris greater than 3 inches in diameter. Surface fuel loading (quantities) influences fire behavior. High surface fuel loading can result in high-severity fire effects because the fire can smolder in place for long periods and transfer more heat into soils and tree stems. Lessening surface fuels reduces fire intensity and severity. Scott and Burgan's (2005) report on 40 fire behavior fuel models classifies the most dominant fuels in the project area as grass and shrub fuels, which are surface fuels consisting of grasses, forbs, shrubs, and Interior Chaparral.

VEGETATION COMMUNITIES

Three primary vegetation communities make up the majority of the overall project area: the Upland Subdivision and the Lower Colorado River Valley region of the Sonoran Desertscrub, and Interior Chaparral (see figure 3.3.2-2). In addition, Interior Riparian Deciduous Forest and Madrean Evergreen Woodland occur in limited extent, such as within the projected subsidence area at Oak Flat. Mining activities have disturbed some portions of the project area, and areas of bare ground and various nonnative invasive plant species are common (Resolution Copper 2016d).

The Sonoran Desertscrub (Arizona Upland subdivision) is composed primarily of cactus, including saguaro (*Carnegiea gigantea*), chollas (*Cylindropuntia* spp.), and prickly pears (*Opuntia* spp.), as well as some common small trees and shrubs, including paloverde (*Parkinsonia* spp.), ironwood (*Olneya* sp.), velvet mesquite (Prosopis velutina), acacias (*Senegalia* spp.), and creosotebush (*Larrea tridentata*). This desertscrub community is undergoing an infrequent, high-severity fire regime (FR V) that would undergo stand-replacing fire with an average fire return interval of 103 to 1,428 years (Missoula Fire Sciences Laboratory 2012). Infrequent fires are due to the slower and often inadequate accumulation of fuel in desert systems (Worthington and Corral 1987). When it does occur, wildfire typically kills Sonoran Desert cactus species (McLaughlin and Bowers 1982).

The Sonoran Desertscrub (Lower Colorado River Valley subdivision) is composed of creosotebush, white bursage (*Ambrosia dumosa*), and saltbush (*Atriplex* sp.). Creosotebush-white bursage communities have been described as "essentially nonflammable" because the shrubs are too sparse to carry fire (Humphrey 1974).

Creosotebush is poorly adapted to fire because of its limited sprouting ability (Brown and Minnich 1986), particularly under severe burning conditions (Marshall 1995). White bursage similarly is killed by fire and has been found to have limited sprouting and seedling establishment even after 5 years post-fire (Brown and Minnich 1986).

Interior chaparral comprising shrub live oak (*Quercus turbinella*; also known as Sonoran scrub oak) experiences fire-return intervals of approximately 74 to 100 years (Tirmenstein 1999). Fires typically burn with high severity and cause stand replacement (FR IV). Shrub live oak is well adapted to survive fire, and even after complete stand replacement, the oak typically sprouts vigorously from the root crown and rhizomes (Davis 1977). Burned areas may be completely revegetated with shrub live oak within 4 to 8 years of a high-severity fire (Tiedemann and Schmutz 1966). Post-fire establishment by seed also occurs (Tirmenstein 1999). Following fire, the production of annual grasses may increase until the overstory is reestablished (Tiedemann and Schmutz 1966).

FIRE OCCURRENCE HISTORY

Since 1980, authorities have recorded over 3,900 wildfire ignitions within Pinal County (Logan Simpson 2018). Only 20 of those fires were within the footprint of the proposed project alternatives. Of those fires, only 20 percent ignited naturally; the remainder were a result of various human causes. Figure 3.10.2-3 shows the fire occurrence (ignition points and perimeters of previous fires) within the project boundary from 1980 to 2017. Most of these fires have been less than 1 acre in size. However, between 1979 and 2017, three large wildfires have occurred close to the project area: the Silverona Fire, which broke out in 1979 and consumed 1,730 acres; the Peachville Fire, which occurred in July 2005 and was 9,750 acres; and the Queen Fire, which occurred in 2012 and was 679 acres (Interagency Fuels Treatment Decision Support System 2018). These fire perimeters overlapped, as seen in figure 3.10.2-3.

The Peachville Fire was ignited by lightning on July 18, 2005, and threatened existing mining resources within the project area. The fire burned for 9 days through chaparral fuels and required 199 personnel, seven engines, one dozer, and three water tenders for suppression. Crews were supported by one helicopter for aerial suppression (Tonto National Forest 2005).

Due to the presence of non-native annual grasses, large wildfires that are uncharacteristic of the desert vegetation zone are becoming increasingly common. In addition, growing recreational use and transportation along highways has increased human-caused ignitions in the region. According to the Pinal County CWPP, the areas with the greatest potential for fire ignition, either from natural or human (though unplanned) causes, are found within the Tonto National Forest along the northeastern portion of the CWPP WUI (see figure 3.10.2-3), including Superior and Top-of-the-World. In figure 3.10.2-3, it is evident that most previous fires have occurred along transportation corridors and on NFS lands; fire occurrence on BLM lands is less frequent.

WILDFIRE RESPONSE

Wildland and structural fire response in and adjacent to the project area is provided by local fire departments and districts. The BLM and Tonto National Forest also provide support for initial wildland fire attack for areas within and adjacent to WUI areas. Initial attack response from additional local fire departments and districts can occur under the authority of mutual-aid agreements between individual departments or under the intergovernmental agreements that individual fire departments and districts have with the Arizona State Forester and adjacent fire departments and districts (Logan Simpson 2018).

Tonto National Forest

The project area falls in MA 2F on the Globe Ranger District and MA 3I on the Mesa Ranger District. Under the forest plan, fire management direction in both management areas is as follows:

> Wildland Fires will be managed consistent with resource objectives. Wildland Fires will be managed with an appropriate suppression response. Fire management

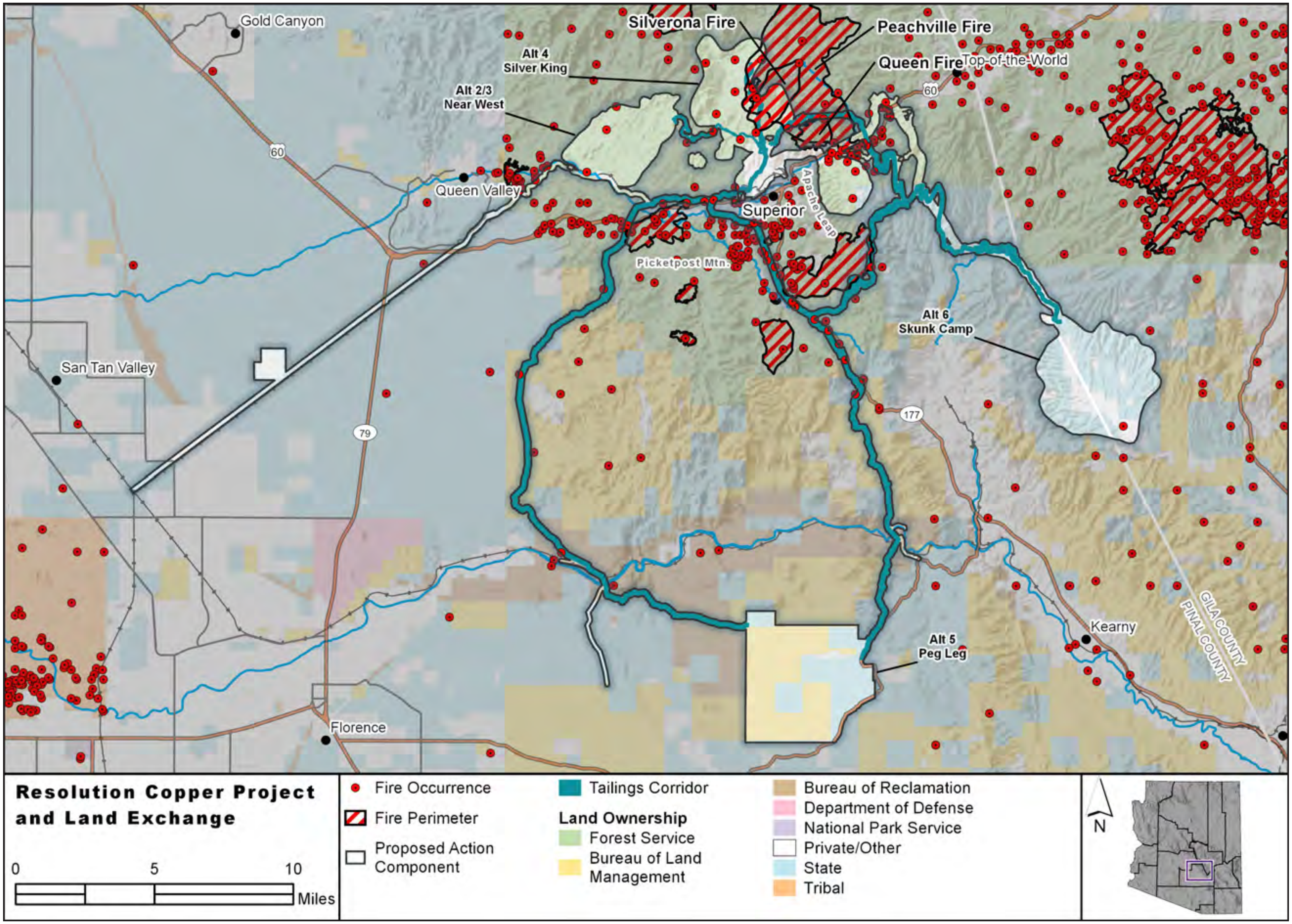


Figure 3.10.2-3. Fire occurrence history for the project area and surrounding lands

> objectives for this area include: providing a mosaic of age classes within the total type which will provide for a mix of successional stages, and to allow fire to resume its natural ecological role within ecosystems.
>
> Wildland Fires or portions of fires will be suppressed when they adversely affect forest resources, endanger public safety or have a potential to damage significant capital investments.

During the height of the fire season when there are multiple fires in northern and central Arizona response zones, there is a draw-down on resources leading to shortages. Responses to fires on the Tonto National Forest are timely but may not involve more than a single resource able to provide equipment and personnel.

BLM Lower Sonoran Field Office

According to the BLM Lower Sonoran Field Office and Safford District Resource Management Plans (Bureau of Land Management 1991, 2012), management response is to fully suppress all unplanned ignitions within the district. The resource management plans direct management actions to implement fuels treatments, suppression activities, and prevention activities that target reducing the size and number of human-caused wildland fires.

State Lands

State Trust lands occur on the periphery of the communities and are included in several of the alternatives. State Trust lands are administered by the ASLD and are managed for a variety of uses. The ASLD has a forestry division with fire and fuels crew who work on fire prevention activities, including hazardous fuels treatments around at-risk communities in the WUI. The Arizona Department of Forestry and Fire Management is responsible for prevention and suppression of wildland fire on State Trust land and private property located outside incorporated communities. The agency has ready access to over 3,000 local firefighting vehicles and more than 2,700 trained state and local wildland firefighters plus substantial national resources from Federal agencies.

Private Lands

Pinal County fire departments and districts maintain wildland fire response teams supported by various engines and other wildland equipment. Wildland fire response teams are composed of personnel with various levels of wildland firefighting training, including red-carded firefighters. Specially trained wildland fire response teams not only provide suppression response to brush fires but also community awareness programs and structural-fire risk assessments (Logan Simpson 2018).

The Town of Superior is served by the Superior Fire Department. The fire department has improved wildland fire suppression response and continues public education and outreach programs concerning wildland fire threat and home-ignition-zone recommendations.

The community of Top-of-the-World is outside a fire district, is not under Forest Service jurisdiction for fire protection, and is outside of fire department jurisdiction. The Arizona Department of Forestry and Fire Management provides fire suppression. The community is prioritized in the Pinal County CWPP for fuel treatments because of its moderate risk and potential slow response times.

Resolution Copper

Resolution Copper Mining, LLC (called RCML in the quoted material here), holds an Emergency Services Agreement with the Town of Superior (called the Town, in the quoted material) for the provision of emergency services to the RCML property. In the Emergency Services Agreement, the Town agrees to

> [provide] certain emergency services . . . to the RCML Property. In the event RCML acquires additional property in the vicinity of the Town through a land exchange with U.S. Government or from BHP Copper Inc., such additional real

> property shall be considered part of the RCML Property for purposes of this Agreement and the Town shall provide or cause to be provided Emergency Services to all of the RCML Property, including such additional real property. (Town of Superior 2008)

Emergency services include police services, fire suppression services, and ambulance services. Specific to fire services, the agreement states:

> Fire suppression services, which shall include emergency fire suppression services for fire outbreaks on the surface and in above-ground improvements on the RCML Property. Nothing herein shall require the Town to provide fire suppression services for any underground fire on the RCML Property. (Town of Superior 2008)

The “Apache Leap Special Management Area Management Plan” (U.S. Forest Service 2017c) outlines the vision for the Apache Leap SMA. The “Vision Statement” (provided in appendix C of the “Apache Leap Special Management Area Management Plan”) describes a vision for ongoing access by the Forest Service into the Apache Leap SMA for fire suppression actions (U.S. Forest Service 2017c).

AT-RISK COMMUNITIES AND WILDLAND-URBAN INTERFACE

The Arizona Department of Forestry and Fire Management compiles a list of communities at risk from wildfire each year. Six communities fall within Pinal County and three communities fall within the project area (Arizona Department of Forestry and Fire Management 2018). Typically, these at-risk communities are located within a defined WUI. The Tonto National Forest adopted the following definition for WUI in its Amendment #25:

> Wildland Urban Interface (WUI)—The line, area, or zone where structures and other human development meet or intermingle with undeveloped wildland or vegetation fuels.

The project area falls within the Tonto National Forest–defined WUI (see figure 3.10.2-2) but portions also fall within the broader WUI delineated for the Pinal County CWPP (Logan Simpson 2018). Figure 3.10.2-2 presents a map of both the Forest Service–derived and CWPP-derived WUI boundaries, relative to the project boundary.

The Pinal County CWPP analyzes risk and makes recommendations to reduce the potential for unwanted wildland fire within at-risk communities. Three of the communities within the Pinal County CWPP WUI—Superior, Queen Valley, and Top-of-the-World—fall within the project area. The CWPP makes recommendations for risk ratings for all communities within the county. Those 2018 recommendations rate all three communities as having moderate risk of wildfire. These ratings were used as the basis for the analysis in the following text. The Queen Valley community is adjacent to the project area and is discussed in the context of potential wildfire spread. The following is taken from the Pinal County CWPP (Logan Simpson 2018) and describes the conditions of these moderate-risk WUI communities.

Superior Sub-WUI

The Superior fire department provides structural and wildland fire response to over 1,459 housing units. The Superior sub-WUI is composed primarily of high wildland fire-risk vegetation associations in conjunction with a steadily rising elevation and slope from south to north throughout the sub-WUI. Substantial threats to structure and infrastructure are found within and adjacent to the community. Several large wildfires have occurred within or adjacent to the community. Vegetative associations within this sub-WUI range from desert scrub types on the desert floor to mixed desert shrub associations in the mountain foothills. These areas of the sub-WUI can create extreme risk during years of extraordinary rainfall, due to elevated growth of fine fuels. Analysis of fire-start data for the past 36 years (1980–2016) indicates that the highest incidences of ignition occur within or adjacent

to Tonto National Forest lands along the northern portion of the sub-WUI. The majority (76 percent) of the Superior sub-WUI has a moderate wildfire risk, with an elevated risk from a density of developed areas in proximity to high-risk wildland fuels and elevated areas of risk in the Queen Creek riparian corridor; the overall wildland fire risk rating of the sub-WUI is moderate.

Top-of-the-World Sub-WUI

The Top-of-the-World sub-WUI includes the unincorporated community of Top-of-the-World and the Oak Flat area. Top-of-the-World is a rural community located along U.S. 60 near the Pinal County line. U.S. 60 is the only transportation route for this community. According to the 2000 census data, the population of the community of Top-of-the-World is 236 (Logan Simpson 2018). There are 196 housing units, of which 47 are classified as owner-occupied units and 61 are classified as detached single-family units, while 135 are classified as mobile homes. Top-of-the-World is not within a fire district and therefore has an Insurance Services Office (ISO) rating of 10 (the worst rating class for fire protection: 10 indicates virtually no protection). Fire suppression is provided by the Arizona Department of Forestry and Fire Management. The highest risk for wildland fires within the Top-of-the-World sub-WUI is a result of the combination of volatile vegetative associations occurring in conjunction with southerly exposures of increasing steep slopes. These areas of the sub-WUI can create extreme risk during normal precipitation years as well as during years of extraordinary rainfall. Analysis of fire-start data for the past 36 years (1980–2016) indicates that the highest incidences of ignition occur within or adjacent to the Tonto National Forest lands along the northern and eastern portions of the sub-WUI. The majority (97 percent) of the Top-of-the-World sub-WUI has a moderate to high wildfire risk, with an elevated risk from ignition history in areas of high-risk wildland fuels; the overall wildland fire risk rating of the sub-WUI is moderate.

Queen Valley Sub-WUI

The Queen Valley sub-WUI has areas at high risk from brush fires around homes with a high density of brush growth on adjacent hillsides. The population of Queen Valley has been declining over the last decade, with 712 residents in 2016. The Queen Valley Fire District has an ISO rating of 8. The Queen Valley sub-WUI is primarily composed of areas at moderate to high risk from wildland fire during extreme rainfall years. The Queen Valley sub-WUI consist of a steadily rising elevation and areas of increasing slope from the lower elevations of Queen Valley to the foothills of the Superstition Mountains within the northern portion of the sub-WUI. Vegetation associations within this sub-WUI range from desert scrub types on the desert floor to mixed desert shrub and woodlands in the foothills of the Superstition Mountains. The majority (92 percent) of the Queen Valley sub-WUI is classified at moderate risk for wildland fire (Logan Simpson 2018); the sub-WUI has an elevated risk from the density of developed areas in proximity to high-risk wildland fuels, but the area has a low to moderate ignition history and overall low wildfire effects.

COMMUNITY VALUES AT RISK

In addition to communities at risk, there are several values at risk that were identified in the Pinal County CWPP and by the Forest Service that are within or adjacent to the project area and analysis area. These include campgrounds, recreational trails and recreational areas, power lines, communication facilities, cultural and historic resources, sensitive wildlife habitat, watersheds, water supplies, and air quality.

3.10.2.4 Environmental Consequences of Implementation of the Proposed Mine Plan and Alternatives

Proposed mining activities have the potential to change fuels and fire management conditions. The factors considered to address the fuels and fire management issues stated previously are (1) the type and location of activities that would change fuel loads, and (2) the type and location of activities that would increase risk for fire. Impacts associated with both fuel loading and fire risk are qualitatively assessed, based on the type and location of mining and mining-related activities.

Alternative 1 – No Action

Under the no action alternative, the project area would remain in its present condition. There would be no change to fuels and fire management conditions. Fires resulting from lightning would continue to occur at the same frequency. Human-caused fires from recreation, ranching, and transportation could increase over time as population continues to increase in the area and a corresponding increase in use of public land occurs. Continued invasion by annual grasses combined with climate change would likely result in a continuation of trends of increasing wildfire size and intensity, and increased potential for high-intensity fires when ignitions do occur. Continued growth of the WUI would expose more life and property to wildfire. Fire prevention and fire response would remain the same, with no change to access for emergency response.

Impacts Common to All Action Alternatives

The action alternatives are similar with respect to the types of mining activities proposed. The location of certain mining activities, particularly the locations of tailings, do vary by alternative. Most differences between alternatives are considered insignificant when assessing impacts on fuels and fire management, and as such effects common to all alternatives are presented. Mining operations or implementation of projects occurring on NFS, BLM, State, Pinal County, or Gila County land would need to comply with any fire restrictions that are in effect. Where differences between alternatives would have different impacts on fuels and fire management, these impacts are discussed separately by alternative.

General changes in fuel loading or risk of accidental ignition caused by mine activities include the following:

- Blasting. Regular blasting would take place under controlled conditions underground, although some aboveground blasting might be used during the construction phase for other facilities or pipelines. This could increase risk of ignition, but typically blasting is done with emergency response crews standing by.
- Increased vehicle traffic. Increased vehicle traffic increases risk of accidental ignition, through careless disposal of smoking materials, vehicles pulling over on combustible dry vegetation, or impact sparks from loose mechanical parts.
- Storage and transportation of flammable materials would not necessarily increase risk of accidental ignition but could worsen any fire that happened to occur. Adhering to hazardous and flammable material storage requirements would reduce this risk.
- Fuel loading from clearing of vegetation. Any stockpiled vegetation left to dry out would increase fuel loads, increasing the overall fire risk.
- Impacts on vegetation from water use. A number of riparian systems are predicted to be impacted by groundwater drawdown, but mitigation is largely expected to maintain vegetation communities in a relatively healthy condition and not increase fuel loading (see section 3.7.1 for analysis of these riparian areas).
- Introduction of noxious weeds. All surface-disturbing project activities increase the potential for spread of noxious and invasive weeds, which can increase fuel loads and overall fire risk. These effects would be reduced, but not eliminated

by implementation of noxious weed management plans (see section 3.3 for analysis of noxious weeds).

- Construction activities. Use of power equipment and welding equipment specifically increases the risk of accidental ignition from sparks.
- Reduction in recreational use. Reductions in recreational use over large portions of the Tonto National Forest associated with the tailings storage facility would decrease the risk of accidental ignition caused by recreation, such as vehicles, shooting, or camping. However, this might be offset by the shift of recreation to other areas.

EFFECTS OF RECLAMATION

The tailings storage facility represents a large area of disturbance that would be reclaimed after closure. The success of reclamation and the ability to reestablish vegetation on the tailings storage facility surface would have a large effect on post-closure fire risk. Potential reclamation success is analyzed in detail in section 3.3. Overall, in areas where ground disturbance is relatively low, and soil resources (e.g., nutrients, organic matter, microbial communities) and vegetation propagules (e.g., seedbank or root systems to resprout) remain relatively intact, it would be expected that vegetation communities could rebound to similar pre-disturbance conditions in a matter of decades to centuries. In contrast, for the tailings storage facility, which would be covered in non-soil capping material (such as Gila Conglomerate), biodiversity and ecosystem function may never reach the original, pre-disturbance conditions even after centuries of recovery. The vegetation on the reclaimed tailings storage facility might be more sparse than the natural landscape, but also might increase fuel loading if survivorship of plants is low.

EFFECTS OF THE LAND EXCHANGE

The Oak Flat Federal Parcel would leave Forest Service jurisdiction. This would not impact the Forest Service's ability to fight any potential fires, as the Tonto National Forest would still cover fires occurring on private lands; however, the Tonto National Forest would lose their authority to actively manage wildfire suppression and prescribed fires within the parcel in order to meet management objectives. However, this change in management would not necessarily result in increased fire risk on the Oak Flat Federal Parcel.

The eight offered lands parcels would move into Federal jurisdiction and grant the Forest Service and BLM the authority to manage fuel loads and fire risks within those parcels where there was previously no Federal management. This would enable more cohesive management techniques as the parcels include inholdings surrounded by federally managed land. The respective Federal authority would manage the parcels for multiple uses, of which fire is recognized as a resource management tool with the potential included in a management prescription where it can effectively accomplish resource management objectives. In all, the main effect on fuels and fire management from the transfer of the offered lands parcels to Federal jurisdiction would be the authority of Federal agencies to actively manage for fires and could potentially reduce fire risks in those areas.

EFFECTS OF FOREST PLAN AMENDMENT

The Tonto National Forest Land and Resource Management Plan (1985b) provides guidance for management of lands and activities within the Tonto National Forest. It accomplishes this by establishing a mission, goals, objectives, and standards and guidelines. Missions, goals, and objectives are applicable on a forest-wide basis. Standards and guidelines are either applicable on a forest-wide basis or by specific management area.

A review of all components of the 1985 Forest Plan was conducted to identify the need for amendment due to the effects of the project, including both the land exchange and the proposed mine plan (Shin 2019). As a result of this review, 30 standards and guidelines were identified as applicable to management of ecosystems and vegetation communities. None of these standards and guidelines was found to require amendment to the proposed project, on either a forest-wide

or management area-specific basis. For additional details on specific rationale, see Shin (2019).

SUMMARY OF APPLICANT-COMMITTED ENVIRONMENTAL PROTECTION MEASURES

A number of environmental protection measures are incorporated into the design of the project that would act to reduce potential impacts on fuels and fire management. These are non-discretionary measures and their effects are accounted for in the analysis of environmental consequences.

In appendix M of the GPO, Resolution Copper has committed to various measures to reduce impacts on fuels and fire management:

- Any vegetation cleared from the site would be temporarily stored on-site at a location with minimal fire risk, well within a cleared area away from ignition sources. Handheld and large equipment (e.g., saws, tractors) used for vegetation clearing would be equipped with working spark arresters. Resolution Copper would take additional precautions if work is to be conducted during critical dry season, which may include larger amounts of extinguishing agents, shovels, and possibly a fire watch.
- Parking will be prohibited on vegetated areas and proper disposal of smoking materials will be required. All surface mine vehicles would be equipped with, at a minimum, fire extinguishers and first aid kits.
- Resolution Copper will establish an emergency service or maintain contracts and agreements with outside emergency response contractors for emergency response support services to surface facilities on a 24/7 on-call basis. Fire emergency and response procedures specific to underground operations would be prepared and implemented.

Alternative 2 – Near West Proposed Action

Potential impacts on fuels and fire management would be the same as described earlier in this section in “Impacts Common to All Action Alternatives.” The tailings facility for Alternative 2 would be located on NFS lands, in an area that has historically received very few wildfire ignitions. Although the tailings facility footprint includes a portion of the Queen Valley WUI, the majority of the footprint is 2 miles or more from the community. Fuel types in the area of the tailings facility are characterized by grass/shrub fuels and Sonoran Desert vegetation that does not typically transmit wildfire. Following very wet years, however, these fuel types would be at elevated risk of large fire spread due to the presence of annual grass fuels. This risk may be mitigated, but not eliminated, using noxious weed management techniques. Fire response to the area would be rapid, due to the emergency services provided by both the Tonto National Forest and the Town of Superior. Fires have a better chance of being contained during initial attack, before they can gain in size.

Alternative 3 – Near West – ULTRATHICKENED

Potential impacts on fuels and fire management would be the same in magnitude and nature as those described for Alternative 2 since they have the same footprint, and differences in the tailings site embankment structure would not increase or decrease potential impacts between the two alternatives.

Alternative 4 – Silver King

Potential impacts on fuels and fire management from proposed project activities would be similar to those described earlier in this section in “Impacts Common to All Action Alternatives,” but the location of the tailings facility, the location of the filter plant and loadout facility, and other emergency storage ponds would increase the West Plant Site footprint and require different access road alignment along Silver King Mine Road, compared with the GPO and Alternatives 2, 3, 5, and 6. Because the facilities would be contained within the West Plant Site,

the potential exposure of surrounding areas to West Plant Site–related ignitions resulting from transportation of materials or construction activities would be slightly reduced.

Alternative 4 includes areas classified with shrub fuels (SH7) that burn with high intensity in the event of an ignition. Intense fire behavior was observed within the footprint of Alternative 4 during the Peachville Fire, which burned a portion of the proposed tailings area in 2005. Several after-wildfire ignitions have also occurred within the footprint over the past several decades. The southern portion of the Alternative 4 footprint is located within the WUI for the town of Superior, showing that the location would expose life and property to wildfire impacts, should an ignition occur. Because of the close proximity to Superior, fire response to the area would be rapid due to the emergency services provided by both the Tonto National Forest and the Town of Superior. Fires have a better chance of being contained during initial attack, before they can gain in size.

Alternative 5 – Peg Leg

Potential impacts on fuels and fire management from proposed project activities would be similar to those described earlier in this section in "Impacts Common to All Action Alternatives." The area of disturbance would be larger under Alternative 5 in order to accommodate two separate facilities, one for NPAG tailings and one for PAG tailings, as well as ancillary tailings facilities such as borrow and storage areas, roads, and realignment of two existing transmission line corridors (10,782 acres). This would increase construction impacts on fuels and fire management and increase the length of the perimeter that abuts wildland fuels, elevating the potential for wildfire spread. However, the tailings facility is located at a greater distance from residential areas, and outside of any delineated WUI areas, which reduces the potential for fire originating from tailings activities to spread to homes and structures. Alternative 5 tailings facilities are also located in an area that has experienced lower fire occurrence historically than locations for other alternatives.

Alternative 5 would use ASLD, BLM, and private lands for the tailings facilities. Fire management would therefore differ when compared with other alternatives, including potentially slower response times due to the location. BLM fire management policy is to fully suppress all unplanned ignitions that occur in the district. Fire suppression on ASLD and private lands is provided by the Arizona Department of Forestry and Fire Management. Fires have a better chance of being contained during initial attack, before they can gain in size.

Alternative 6 – Skunk Camp

Potential impacts on fuels and fire management from proposed project activities would be similar to those described earlier in this section in "Impacts Common to All Action Alternatives." Similar to Alternative 5, Alternative 6 would be located at a greater distance from residential areas than Alternatives 2, 3, and 4, but slightly closer to WUI areas along the SR 177 corridor than Alternative 5. The footprint for the tailings facility under Alternative 6 would be substantially larger than under Alternatives 2, 3, and 4, but smaller than the footprint for Alternative 5. The tailings facility would be located in an area of steep terrain and heavy shrub fuels (fuel model SH7) that would burn with intense fire behavior in the event that an ignition occurs; however, historically fire occurrence in the area has been infrequent and potential ignitions originating from the tailings facility would be limited, due to the nature of the activities there and fencing that prevents unauthorized access.

This alternative is the only alternative that would require a new transmission line to be constructed outside of an existing corridor. This would increase the risk of fire, by exposing surrounding wildland fuels to construction-related ignition sources.

This alternative would use ASLD and private lands. Fire suppression on ASLD and private lands is provided by the Arizona Department of Forestry and Fire Management. Fires have a better chance of being contained during initial attack, before they can gain in size.

Cumulative Effects

The Tonto National Forest identified the following list of reasonably foreseeable future actions as likely to occur in conjunction with development of the Resolution Copper Mine, and as having potential to contribute to incremental changes in fuels and fire management conditions near the Resolution Copper Mine. As noted in section 3.1, past and present actions are assessed as part of the affected environment; this section analyzes the effects of any RFFAs, to be considered cumulatively along with the affected environment and Resolution Copper Project effects.

- *APS Herbicide Use within Authorized Power Line Rights-of-Way on NFS lands*. APS has proposed to include Forest Service–approved herbicides as a method of vegetation management, in addition to existing vegetation treatment methods, on existing APS transmission rights-of-way within five National Forests: Apache-Sitgreaves, Coconino, Kaibab, Prescott, and Tonto National Forests. If approved, the use of herbicides as well as currently authorized treatments would become part of the APS Integrated Vegetation Management approach. An EA with a FONSI was published in December 2018. The EA determined that environmental resource impacts would be minimal, and the use of herbicides would prevent and/or reduce fuel build-up that would otherwise result from rapid, dense regrowth and sprouting of undesired vegetation.
- *Ray Land Exchange and Proposed Plan Amendment*. ASARCO is also seeking to complete a land exchange with the BLM by which the mining company would gain title to approximately 10,976 acres of public lands and federally owned mineral estate located near ASARCO's Ray Mine in exchange for transferring to the BLM approximately 7,304 acres of private lands, primarily in northwestern Arizona. It is known that at some point ASARCO wishes to develop a copper mining operation in the "Copper Butte" area west of the Ray Mine. Under the proposed action, fire management on the selected lands would no longer be managed under their current respective resource management plans but would instead fall under the control of the new landowner. Wildfire management for the offered lands would fall under the administration of the BLM.
- *Tonto National Forest Travel Management Plan*. The Tonto National Forest is currently in the process of developing a Supplemental EIS to address certain court-identified deficiencies in its 2016 Final Travel Management Rule EIS. This document and its implementing decisions are expected within the next 2 years. Specifically, the Supplemental EIS currently proposes a total of 3,708 miles of motorized routes open to the public, a reduction from the 4,959 miles of motorized open routes prior to the Travel Management Rule. Limiting availability of motorized routes open to the public would result in reduced access to recreational activities currently practiced on the Forest, including sightseeing, camping, hiking, hunting, fishing, recreational riding, and collecting fuelwood and other forest products. Such a reduction in miles of available motorized routes has the potential to lower overall risks of inadvertent human-induced wildfire.

The RFFAs concerning APS's new Integrated Vegetation Management strategy using herbicides would act to reduce the overall fuel loads and fire potential in and around the proposed Resolution Copper Mine. This would incrementally reduce fuel loads, reduce wildfire risk, and mitigate potential extreme fire behavior when considered together with development of the Resolution Copper Project. The Ray Land Exchange would remove over 10,000 acres from Federal ownership and reduce the ability for BLM to manage resources to reduce wildfire risk, potentially increasing fuel loading. Combined with the potential for accidental ignition from mining activities that might occur on the parcels, this increases wildfire risk when considered together with development of the Resolution Copper Project.

Mitigation Effectiveness

The Forest Service is in the process of developing a robust mitigation plan to avoid, minimize, rectify, reduce, or compensate for resource impacts that have been identified during the process of preparing this EIS. Appendix J contains descriptions of mitigation concepts being considered and known to be effective, as of publication of the DEIS. Appendix J also contains descriptions of monitoring that would be needed to identify potential impacts and mitigation effectiveness. As noted in chapter 2 (section 2.3), the full suite of mitigation would be contained in the FEIS, required by the ROD, and ultimately included in the final GPO approved by the Forest Service. Public comment on the EIS, and in particular appendix J, will inform the final suite of mitigations.

There were no mitigation measures applicable to fuels and fire that were considered required; therefore, no mitigation ideas were considered in the analysis.

UNAVOIDABLE ADVERSE IMPACTS

While increased risks of fire ignition from mine activities cannot be entirely prevented, risks are expected to be substantially mitigated through adherence to a fire plan that requires mine employees to be trained for initial fire suppression and to have fire tools and water readily available.

Other Required Disclosures

SHORT-TERM USES AND LONG-TERM PRODUCTIVITY

Impacts from increased mine-related traffic, increased fire hazard, and hazardous materials use in mine operations would be short-term impacts that would end with mine reclamation.

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

With respect to fuels and fire management, there are not expected to be any irretrievable or irreversible impacts on resources. Vegetation and fuels in the project area would be constantly changing as reclamation procedures are implemented. Eventually, reclamation is expected to return site vegetation to a state that is reminiscent of existing vegetation communities in the area.

3.10.3 Hazardous Materials

3.10.3.1 Introduction

Hazardous materials in the context of this project include fuels, chemicals, and explosives that are used for mine equipment and operations. These materials must be transported to the mine properties, stored, and if not consumed by the process, disposed of properly.

3.10.3.2 Analysis Methodology, Assumptions, and Uncertain and Unknown Information

Analysis Area

The geographic extent of the analysis area for hazardous materials, as shown in figure 3.10.3-1, encompasses any environmental impacts that may result from the transport, storage, use, or disposal of hazardous materials at the proposed project. Thus, it includes all primary mine components (East Plant Site, West Plant Site, tailings storage proposed and alternative locations, MARRCO corridor and filter plant and loadout facility, and linear facilities such as pipelines), as well as primary transport routes to and from each location. Utility corridors were not considered in the analysis area, as the use and risk of release of hazardous materials in these areas is considered negligible. In terms of supply routes, while there is no guarantee that shipments to mine facilities, including those of hazardous materials, would come solely from the Phoenix metropolitan area eastward along U.S. 60, this is considered the most likely scenario.

The analysis area for hazardous materials encompasses the operational areas of the proposed project (i.e., mine process facilities, fuel storage tanks, storage ponds), where hazardous materials would be used and stored. The potential exists at these locations for accidental leaks, spills, or releases to the environment (e.g., soils, vegetation, wildlife, aquifers, surface water drainages).

The temporal bounds of analysis for hazardous materials for the project includes the construction, operations, and closure and reclamation phases.

Note that the potential for and impacts of a release of concentrate, tailings, and process water during a pipeline failure or catastrophic failure of a tailings facility are analyzed in Section 3.10.1, Tailings and Pipeline Safety; the anticipated impacts from the expected migration of seepage from the tailings facility are analyzed in Section 3.7.2, Groundwater and Surface Water Quality; and the anticipated impacts from air emissions are analyzed in Section 3.6, Air Quality.

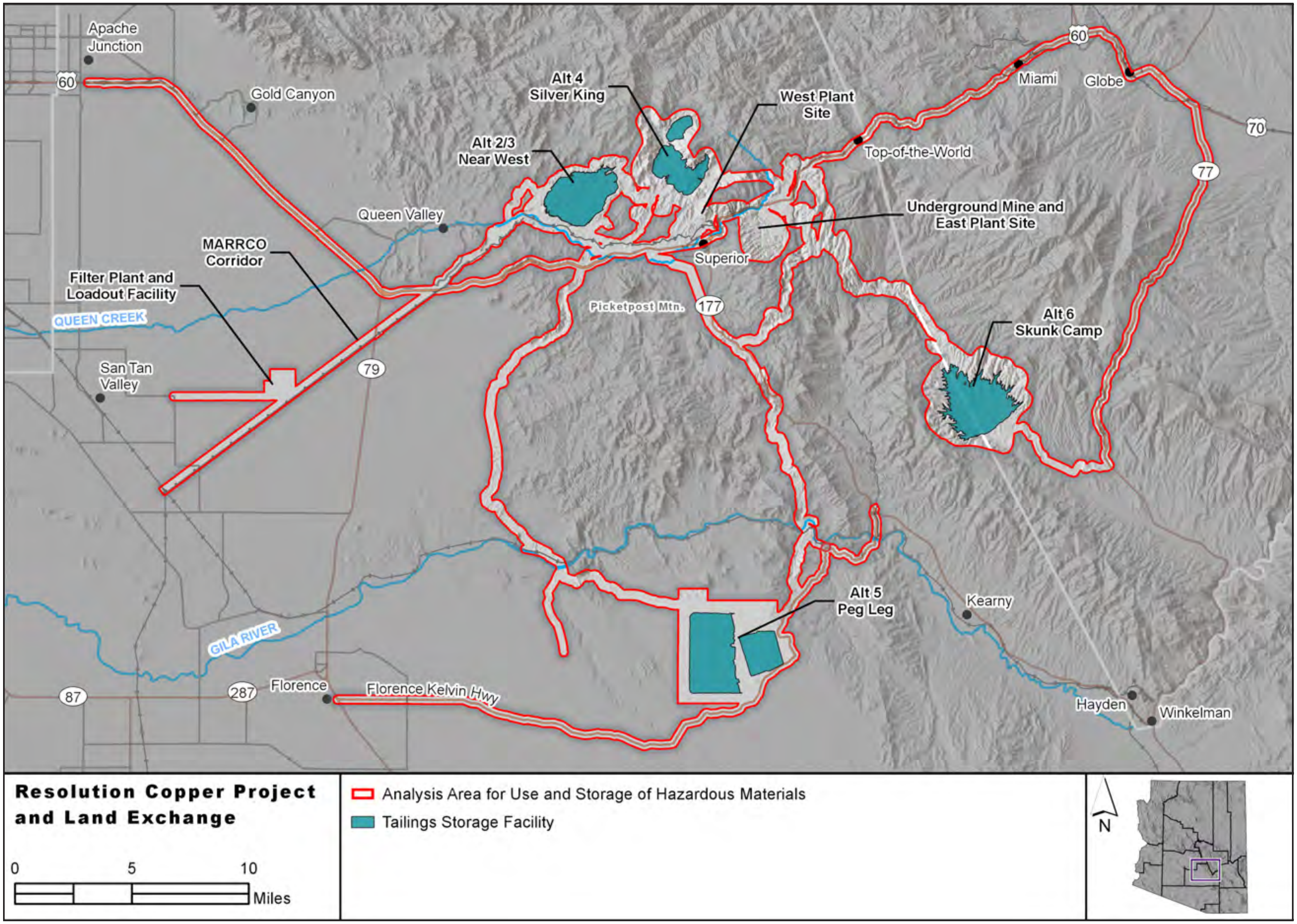


Figure 3.10.3-1. Hazardous materials analysis area

3.10.3.3 Affected Environment

Relevant Laws, Regulations, Policies, and Plans

The use, storage, transport, and disposal of hazardous materials are governed by a variety of Federal and State laws, as well as Forest Service guidance. For more detail on the applicable guidance, see Newell and Garrett (2018c).

Primary Legal Authorities Relevant to the Hazardous Materials

- Resource Conservation and Recovery Act, including mining waste exclusion provisions (Subtitle C)
- Arizona Revised Statutes Title 49, Chapter 5 (Hazardous Waste Disposal)
- Emergency Community Planning and Right to Know Act
- Arizona Pollutant Discharge Elimination System (AZPDES) and Stormwater Pollution Prevention Plans
- Forest Service Manual 2100, “Environmental Management,” Chapter 2160, “Hazardous Materials Management”
- BLM Manual 1703, “Hazard Management and Resource Restoration (HMRR) Program”

Existing Conditions and Ongoing Trends

HISTORICAL AND CURRENT HAZARDOUS MATERIALS USE

Hazardous materials have historically been used for mining operations at the East Plant Site and West Plant Site and are currently being used for exploratory operations. The tailings facilities and filter plant and loadout facility are, in general, undeveloped natural desert that do not have a historical or current use of hazardous materials. Therefore, the following discussion provides the existing conditions for hazardous materials at the East Plant Site and West Plant Site.

EAST PLANT SITE

The East Plant Site is at the former site of the Magma Mine, which employed the use of hazardous materials like those that Resolution Copper currently uses for mineral exploration activities. Because the East Plant Site is currently in use, all Federal and State laws regarding the storage, use, transportation, and disposal of hazardous materials must be followed. Hazardous materials used at the East Plant Site for the exploratory operations include diesel fuel, oil/lubricants, antifreeze, and solvents. These materials are used for the operation and maintenance of mining equipment aboveground and belowground and are delivered to the East Plant Site by delivery trucks using Magma Mine Road from U.S. 60. Gasoline is not stored at the East Plant Site, but vehicles traveling to and parked at the East Plant Site use gasoline. At the East Plant Site, hazardous materials are stored in appropriate sealed containers (tanks, drums, and totes). Resolution Copper stores diesel fuel in an existing aboveground storage tank. The mine collects spent hazardous materials and either disposes of or recycles them with qualified vendors. To prevent potential surface spills from spreading and leaving the East Plant Site, a contact water basin contains surface water runoff.

WEST PLANT SITE

Parts of the West Plant Site were historically used as a concentrator and smelter site for the Magma Mine. The concentrator became operational in 1914, and the smelter site was operational between 1924 and 1972. These historic-era facilities are located adjacent to the town of Superior.

Particulate emissions from the smelter stack and fugitive emissions from other mineral processing operations (e.g., crushing and concentrating) led to soil contamination with elevated levels of arsenic, copper, and

lead. In 2011, Resolution Copper conducted a site characterization study under the authority of the ADEQ Voluntary Remediation Program to understand the nature and extent of the historical soil contamination. The results of the site characterization study are presented in "Site Characterization Report for the West Site Plant, Superior, Arizona" (Golder Associates Inc. 2011).

After Resolution Copper conducted the site characterization study and the nature and extent of the soil contamination was better understood, they developed site-specific soil remediation levels for the contaminated soils that were approved by the ADEQ Voluntary Remediation Program. Resolution Copper then developed a Remedial Action Work Plan for returning the affected area to pre-contamination levels. The Remedial Action Work Plan involves excavating the contaminated soils, using the contaminated soils as fill for reclamation efforts at Tailings Pond 6, and capping the reclaimed tailings pond with cover material in accordance with APP requirements. The Remedial Action Work Plan was approved by the ADEQ in 2016, and remediation efforts for the historic smelter site are currently underway. Removal of the smelter building and stack was completed in December 2018.

The West Plant Site currently processes development rock from the East Plant Site's exploratory operations. Because the West Plant Site is a currently operating mine facility, all Federal and State laws regarding the storage, use, transportation, and disposal of hazardous materials must be followed. Hazardous materials currently used at the West Plant Site are the same as described for the East Plant Site, except for the lab chemicals and reagents used at the West Plant Site's laboratory to test the development rock. These chemicals are stored in appropriate individual containers in the Chemical Storage Facility in Building 203. The West Plant Site employs stormwater management controls and containment measures to prevent the spread of chemicals following an accidental release.

3.10.3.4 Environmental Consequences of Implementation of the Proposed Mine Plan and Alternatives

Alternative 1 – No Action

Under the no action alternative, the project area would remain in its present condition. The potential of additional impacts from hazardous materials would not occur, and there would be no risk of a potential accident or spill involving hazardous materials from the proposed project activities. Transportation of hazardous materials along U.S. 60 would continue to occur for non-mine-related businesses and industries that currently use the highway for hazardous materials deliveries.

Impacts Common to All Action Alternatives

Based on the preliminary GPO, potentially hazardous materials, including petroleum products, processing fluids, and reagents and explosives, would be transported to and stored within the boundaries of the mine in large quantities for use in various operational components of the mine (Resolution Copper 2016d). Hazardous and non-hazardous materials and supplies are included in section 3.9 of the GPO, "Materials, Supplies and Equipment." Transportation of hazardous materials as well as proposed mining activities have the potential to release these materials into the environment and affect the natural condition of soils, vegetation, wildlife, surface water and groundwater resources, and air quality within the analysis area. The issues considered in this section are (1) the use, storage, and disposal of hazardous materials within the project area; (2) the transportation of hazardous materials to the project area; and (3) the potential for those materials to enter the environment in an uncontrolled manner, such as by accidental spill.

An accidental release or significant threat of a release of hazardous chemicals into the environment could result in direct and indirect harmful effects on or threat to public health and welfare or the environment. The environmental effects of a hazardous chemical release would depend on the substance, quantity, timing, and location of the

release. A release event could range from a minor diesel fuel spill within the boundaries of the mine, where cleanup would be readily available, to a major or catastrophic spill of contaminants into a stream or populated area during transportation. Some hazardous chemicals could have immediate destructive effects on soils and vegetation, and there also could be immediate degradation of aquatic resources and water quality if spills were to enter surface water. Spills of hazardous materials could potentially seep into the ground and contaminate the groundwater system over the long term.

EFFECTS OF THE LAND EXCHANGE

The land exchange would have an effect on the potential presence and use of hazardous materials on these lands.

The Oak Flat Federal Parcel would leave Forest Service jurisdiction. The role of the Tonto National Forest under its primary authorities in the Organic Administration Act, Locatable Regulations (36 CFR 228 Subpart A), and Multiple-Use Mining Act is to ensure that mining activities minimize adverse environmental effects on NFS surface resources; this includes use of hazardous materials. The removal of the Oak Flat Federal Parcel from Forest Service jurisdiction negates the ability of the Tonto National Forest to regulate effects on these resources. No hazardous materials are presently being used at the Oak Flat Federal Parcel; once the land exchange occurs, Resolution Copper could use hazardous materials on this land without approval. However, all other environmental laws regarding the use, storage, transport, and disposal of hazardous materials would still apply and need to be followed.

The offered land parcels would enter either Forest Service or BLM jurisdiction. This would provide a new level of control over the use of hazardous materials on these properties.

EFFECTS OF FOREST PLAN AMENDMENT

The Tonto National Forest Land and Resource Management Plan (1985b) provides guidance for management of lands and activities within the Tonto National Forest. It accomplishes this by establishing a mission, goals, objectives, and standards and guidelines. Missions, goals, and objectives are applicable on a forest-wide basis. Standards and guidelines are either applicable on a forest-wide basis or by specific management area.

A review of all components of the 1985 forest plan was conducted to identify the need for amendment due to the effects of the project, including both the land exchange and the proposed mine plan (Shin 2019). No standards and guidelines were identified as applicable to hazardous materials. For additional details on specific rationale, see Shin (2019).

SUMMARY OF APPLICANT-COMMITTED ENVIRONMENTAL PROTECTION MEASURES

A number of environmental protection measures are incorporated into the design of the project that would act to reduce potential impacts from hazardous materials and to reduce impacts on public safety from hazardous materials. These are non-discretionary measures outlined in a variety of protection plans (listed here and included in the GPO) and their effects are accounted for in the analysis of environmental consequences.

Applicable emergency response protection plans include the following:

- Spill Prevention Control and Countermeasures Plan (Appendix O of the GPO)
- Emergency Response and Contingency Plan (Appendix L of the GPO)
- Stormwater Pollution Prevention Plan (Appendix W of the GPO)
- Fire Prevention and Response Plan (Appendix M of the GPO)
- Environmental Materials Management Plan (Appendix V of the GPO)
- Explosives Management Plan (Appendix P of the GPO)

- Hydrocarbon Management Plan (Appendix U of the GPO)
- Tailings Pipeline Management Plan (AMEC Foster Wheeler Americas Limited 2019)
- Concentrate Pipeline Management Plan (M3 Engineering and Technology Corporation 2019b)

TRANSPORTATION OF HAZARDOUS MATERIALS

The impacts from the proposed action and the other action alternatives are identical with respect to the type and quantity of hazardous materials used, stored, disposed of, and transported. There may be slight variations in the location of use amongst the alternatives, such as the exact location of hazardous materials storage within the plant site, but these changes are considered insignificant for assessing impacts.

All hazardous materials and petroleum products would be transported to and from the project area by commercial trucks and rail access, in accordance with 49 CFR and 28 ARS. Transporters must be properly licensed and inspected, in accordance with ADOT guidelines. Hazardous materials must be properly labeled, and shipping papers must include information describing the substance, health hazards, fire and explosion risk, immediate precautions, firefighting information, procedures for handling leaks or spills, first aid measures, and emergency response contact information. Because of the quantity and number of daily deliveries, petroleum fuels are of the greatest concern.

Waste that may be classified as hazardous, such as grease, unused chemicals, paint and related materials, and various reagents, would be shipped to an off-site disposal facility licensed to manage and dispose of hazardous waste. Prior to disposal, Resolution Copper would be required to characterize the waste and properly mark and manifest each shipment.

TRANSPORTATION OF HAZARDOUS MATERIALS WITHIN THE MINE

Transportation of hazardous materials within the boundaries of the mine would occur on the primary access roads, in-plant roads between facilities, and haul roads. Hazardous materials would enter and exit the plant along the primary access roads. Once inside, all hazardous materials would be delivered to their appropriate storage location.

Reagents would be received from vendors and stored in individual storage tanks, drums on pallets, dry-storage silos, or a nitrogen tank. Refer to section 3.9 of the GPO, “Materials, Supplies, and Equipment,” for more detail on material being delivered and stored on-site. Deliveries of reagents, diesel fuel and gasoline, and nitrogen would be direct to storage locations. The plant layout would be designed so that these delivery trucks would remain in the right-hand traffic lanes.

FREQUENCY OF SHIPMENTS OF HAZARDOUS MATERIALS

Hazardous materials would be transported to the project area during the pre-mining and active mining phases of the mine. Section 3.4.2.1 of the GPO, “Construction Phase,” provides more detail regarding the estimated shipment of hazardous material in large quantities to and from the East Plant Site or West Plant Site, along with the expected quantities and number of trips. The most sensitive times of the day are considered to be around shift change and early weekday mornings and afternoons during school bus hours on U.S. 60.

ANALYTICAL LABORATORY

The analytical laboratory would be a pre-engineered building located at the West Plant Site. The laboratory would consist of a sample preparation area, a wet laboratory, a metallurgical laboratory, an environmental laboratory, offices, lunchroom, and restrooms. It would contain sample crushers, pulverizers, sample splitters, and a dust collection system to capture and contain any dust generated from this operation. The analytical laboratory would also contain a reagent storage area, balance rooms, and various types of analytical equipment. Disposal of chemical and laboratory waste would follow appropriate regulatory requirements, depending on the waste generated.

STORAGE OF HAZARDOUS MATERIALS WITHIN THE MINE

Storage of hazardous materials would begin during the pre-mining phase and continue through the active mining phase. All hazardous materials storage facilities would be removed during the final reclamation and closure phase of the mine. The storage facilities would be maintained throughout this period. Refer to appendix V of the GPO, “Environmental Materials Management Plan,” for more information.

HAZARDOUS WASTE MANAGEMENT AND DISPOSAL

A waste management plan was prepared for the preliminary GPO. The disposal of hazardous waste and petroleum products, along with the type of storage container, location, use, and quantity of these materials, is described in appendix V of the GPO, “Environmental Materials Management Plan.”

Many of the petroleum products and potential hazardous materials would be consumed during use by the various components of the mining operation and mineral processing circuits. However, potential hazardous waste that may be generated at the mine includes waste paint materials and thinners, chemical wastes such as acetone from the on-site laboratory, and residue wastes from containers or cans. As a generator of hazardous waste, Resolution Copper would be required to file for a hazardous waste identification number from the EPA and register as a hazardous waste generator with the ADEQ. Based on the proposed activities, the Resolution Copper Mine would likely qualify as a conditionally exempt small-quantity generator of hazardous wastes. Conditionally exempt small-quantity generators generate 100 kilograms or less per month of hazardous waste, or 1 kilogram or less per month of acutely hazardous waste.

FATE AND TRANSPORT OF POTENTIAL RELEASES

The potential impacts of accidental releases of hazardous materials or wastes depend on the nature of the material, the amount released, where in the environment the material or waste is released (soil, groundwater, or surface water), and the potential for migration of the material or waste.

POTENTIAL RELEASES TO SOILS OR SURFACE WATERS WITHIN THE MINE

Releases of hazardous materials within the boundaries of the mine could include accidental spills during use, rupture of storage tanks, release during emergency fire or explosion, or improper disposal. In almost all cases, hazardous materials would be released to soils. Release of hazardous materials into soils does not present a major environmental risk. Both wildlife and vegetation would be largely absent within the mine boundaries. Soils absorb and immobilize small amounts of hazardous materials, and within the controlled boundaries of the mine, it would be relatively easy to excavate and dispose of them.

The more significant risk is for hazardous materials, once within the soil matrix, to migrate to surface water or groundwater, either in dissolved phase or through erosion and movement of contaminated soil. With respect to stormwater, the mine stormwater management has been designed with two basic premises in mind: divert all possible stormwater away from the plant site (i.e., East Plant Site or West Plant Site) to avoid the potential for contamination, and treat all stormwater within the plant site as potentially contaminated, to be retained, recycled, and not discharged. For more information, refer to GPO Appendix W, “Stormwater Pollution Prevention Plan;” and GPO Section 4.5.4, “Stormwater Management.” There are no likely exposure pathways where a spill to soils or surface waters within the mine boundary would leave the site and impact downstream wildlife, vegetation, waters, or people.

POTENTIAL RELEASES TO GROUNDWATER WITHIN THE MINE

Any release of hazardous materials to soils presents the potential for release to groundwater, either directly if large enough quantities of hazardous materials are released, or indirectly through infiltration

of precipitation or runoff through contaminated soils. In addition, the various storage ponds would provide a concentration point for potentially contaminated runoff, and infiltration could occur directly to groundwater from these locations.

The process water temporary storage ponds are double-lined with leak detection and collection in accordance with the ADEQ BADCT requirements. Infiltration is unlikely to occur under normal operating conditions, and leak detection is incorporated into the process water portion of the pond (see Section 3.3, “Milling and Processing,” of the GPO).

If an unplanned spill were to occur, once released to groundwater the primary concern is migration of contaminants. Based on groundwater flow modeling (see section 3.7.2), releases underground are unlikely to migrate, as the dewatering has created a large hydraulic sink that prevents outward movement for hundreds of years. Spills at the surface within the East Plant Site would potentially migrate to the Apache Leap Tuff aquifer, which during operations generally would be draining toward the subsidence area and would be unlikely to migrate beyond the property boundaries. The tailings facilities all incorporate a suite of engineered seepage controls to capture seepage, and migration of an unplanned spill would be controlled as a matter of operations.

The primary concern would be spills within the West Plant Site that entered groundwater. These spills would likely migrate toward Queen Creek and eventually downstream. The primary exposure point would likely be Whitlow Ranch Dam, where groundwater is forced to the surface and supports perennial flow. If a spill migrated this far, it could impact wildlife, vegetation, and surface waters; the exact nature of impact is not possible to know without knowing the release volume and type of material released.

POTENTIAL RELEASES DURING TRANSPORTATION

Potential releases of hazardous materials during transportation could occur, but the fate and transport of those hazardous materials depend entirely on where the release occurs and the quantity of the release. In general, releases during transportation of hazardous materials on U.S. 60 could, if sufficient quantities were released, migrate to Queen Creek or Silver King Wash, either directly or as a result of contact between surface runoff and contaminated soil.

SIGNIFICANCE OF POTENTIAL RELEASES

The following uses present little risk of release, or risk of minor releases only:

- Laboratory reagents. Laboratory reagents are used in controlled conditions and in negligible or minor quantities.
- Cleaning fluids. Cleaning fluids generally are used in controlled conditions and in negligible or minor quantities.
- Sulfide mineral processing. These reagents are stored and used in minor quantities or are dry ingredients, presenting little risk for accidental release or migration.
- Hazardous waste. Hazardous waste does not present a high risk of accidental release when stored, transported, and disposed of properly.

Overall, the significant unmitigated risks of released hazardous materials based on amount, storage, and use are as follows:

- Catastrophic release of contaminant or petroleum product (i.e., gasoline, diesel, kerosene, new or used engine and gear oil, transmission fluid) during transportation.
- Catastrophic release of contaminants or major releases of petroleum product at storage tank locations within the mine or from the fuel piping system.

EFFECTS FROM CATASTROPHIC RELEASE DURING TRANSPORTATION

The effects of a catastrophic release of hazardous materials and/or petroleum products during transportation would depend on the specific location and amount of release. In general, there would be direct impacts on plants and wildlife in the immediate vicinity, direct impacts on soil in the immediate vicinity, and possible migration into surface water either directly or via stormwater runoff from contaminated areas. If migration occurs, there would be indirect effects downstream on vegetation, aquatic species, and wildlife. Along U.S. 60, most downstream impacts would occur along Queen Creek and its tributaries. Direct impacts on vegetation could include mortality or long-term loss of vigor; indirect effects could include long-term exposure of wildlife or humans.

There is also the potential for migration into groundwater, depending on the exact location of the release. Typically, a one-time accidental release, even if catastrophic, does not pose as large a risk for groundwater contamination as it does for contamination of surface water or soils, as product is often held up in soil or recovered during the emergency response before migration can occur.

EFFECTS FROM CATASTROPHIC OR MAJOR RELEASES WITHIN THE MINE

Minor amounts of petroleum products accidentally released within the boundaries of the mine can often be completely mitigated. Major releases unable to be completely mitigated can come in two forms: catastrophic release and long-term undetected release.

Catastrophic release would include damage to a storage tank or fuel piping system and the immediate loss of most or all of the stored product. This type of release would differ from a similar catastrophic release experienced during transportation; within the mine there are fewer receptors, less potential for migration, and more opportunities to fully control any spill. In general, there would be immediate direct impacts on soil and vegetation, but there would be little potential for migration beyond the boundaries of the mine either in surface water or groundwater. Most of the areas within the mine site are developed with little vegetation or natural soil, making either direct impacts (mortality, loss of vigor) or indirect impacts (long-term exposure of wildlife or humans to pollutants) unlikely.

In the event of a long-term undetected release, quantities are small enough that there would be no immediate effects on plants or animals and little potential for migration via stormwater. There is a greater potential for direct effects on soil and groundwater in the immediate vicinity, as the minor releases migrate downward undetected. As noted earlier in this section, the only facility with a likely migration downstream is at the West Plant Site, in close proximity to Queen Creek.

Cumulative Effects

The Tonto National Forest identified the following list of reasonably foreseeable future actions as likely to occur in conjunction with development of the Resolution Copper Mine, and as having potential to contribute to incremental changes in hazardous materials conditions near the Resolution Copper Mine. As noted in section 3.1, past and present actions are assessed as part of the affected environment; this section analyzes the effects of any RFFAs, to be considered cumulatively along with the affected environment and Resolution Copper Project effects.

- *Pinto Valley Mine Expansion.* The Pinto Valley Mine is an existing open-pit copper and molybdenum mine located approximately 8 miles west of Miami, Arizona, in Gila County. Pinto Valley Mining Corporation is proposing to expand mining activities onto the Tonto National Forest and extend the life of the mine to 2039. EIS impact analysis is pending. Potential impacts on public health and safety are expected to include the potential for exposure from accidental spills of hazardous materials being transported to or from the mine.
- *Ripsey Wash Tailings Project.* Mining company ASARCO is planning to construct a new tailings storage facility to support its Ray Mine operations. The tailings storage facility is to be situated in the Ripsey Wash watershed just south of the

Gila River approximately 5 miles west-northwest of Kearny, Arizona. The new tailings storage facility would be designed to replace the existing Elder Gulch tailings storage facility and would be operated with the current on-site workforce. The tailings pipeline across Gila River would be double-cased, and a tailings collection pond would be in place in the event of a problem or maintenance issue. Spill control contingency plans as required by the ADEQ would be in place to handle accidents and spills. Hazardous materials spill and/or exposure risks would be low given safety awareness and precaution measures. Cumulative effects from this project are primarily associated with Alternative 5 – Peg Leg, as the same transportation routes would be used, and the pipelines and tailings facilities for the two projects are in close proximity.

- *Ray Land Exchange and Proposed Plan Amendment.* ASARCO is also seeking to complete a land exchange with the BLM by which the mining company would gain title to approximately 10,976 acres of public lands and federally owned mineral estate located near ASARCO's Ray Mine in exchange for transferring to the BLM approximately 7,304 acres of private lands, primarily in northwestern Arizona. It is known that at some point ASARCO wishes to develop a copper mining operation in the "Copper Butte" area west of the Ray Mine. Under the proposed action, BLM would transfer their regulatory, managerial, and administrative responsibility for hazardous materials from the selected lands to the offered lands. Hazardous materials would still be regulated under standards administered by MSHA.

Other future projects not yet planned, such as commercial development, large-scale mining, and pipeline projects, are expected to occur in this area of south-central Arizona during the foreseeable future life of the Resolution Copper Mine (50–55 years). These types of unplanned projects, as well as the specific RFFAs listed here, would contribute incrementally to changes in hazardous materials conditions. Hazardous materials from these projects are expected to include explosives, lubricants, fuels, solvents, antifreeze, transmitted petroleum products, etc. Each project would transport, use, and store hazardous materials to varying degrees based on the type of commercial enterprise. As each new project comes online it would constitute an incremental increase in hazardous materials when considered with the proposed Resolution Copper Project. However, hazardous materials used on mining projects would be regulated under MSHA, and hazardous materials involved in other projects would be regulated under the appropriate State or Federal regulations, depending upon project type and land ownership.

Mitigation Effectiveness

The Forest Service is in the process of developing a robust mitigation plan to avoid, minimize, rectify, reduce, or compensate for resource impacts that have been identified during the process of preparing this EIS. Appendix J contains descriptions of mitigation concepts being considered and known to be effective, as of publication of the DEIS. Appendix J also contains descriptions of monitoring that would be needed to identify potential impacts and mitigation effectiveness. As noted in chapter 2 (section 2.3), the full suite of mitigation would be contained in the FEIS, required by the ROD, and ultimately included in the final GPO approved by the Forest Service. Public comment on the EIS, and in particular appendix J, will inform the final suite of mitigations.

At this time, no mitigation measures have been identified that would be pertinent to hazardous materials. Applicant-committed environmental protection measures have already been detailed elsewhere in this section, would be a requirement for the project, and have already been incorporated into the analysis of impacts.

UNAVOIDABLE ADVERSE IMPACTS

While the risk of hazardous materials spills would increase during construction and active mining phases, following applicable Federal and State laws and regulations for storage, transport, and handling of such materials is expected to mitigate for this risk. Resolution Copper has

prepared a wide variety of emergency response and material handling plans; implementation of these plans minimizes the risk for unexpected releases of hazardous materials and provides for rapid emergency cleanup.

Other Required Disclosures

SHORT-TERM USES AND LONG-TERM PRODUCTIVITY

Impacts from increased mine-related traffic, increased fire hazard, and hazardous materials use in mine operations would be short-term impacts that would end with mine reclamation.

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

Irreversible impacts with respect to public health and safety are not expected. All potential hazards discussed are limited solely to the construction and operations phases and are not expected to remain after closure of the mine. Therefore, they would constitute an irretrievable commitment of resources.

With respect to hazardous materials, there are not expected to be any irretrievable or irreversible impacts on resources. Although there is the potential for contamination of surface water, groundwater, or soils in the event of a spill or accidental release, this is not expected to occur, and environmental remediation is possible (and required by law) if it does occur.

Overview

Potential scenery impacts of the proposed action and its alternatives are assessed using two different but complementary analysis systems: the Forest Service Visual Management System and the BLM Visual Resource Management system. Each involves an evaluation of likely changes to the visual landscape from key observation points, or KOPs, which are points in the landscape determined to be most representative of what viewers may see before and after development of the GPO-proposed project or its alternatives. KOP view analyses focus in particular on anticipated landscape-scale changes in form, line, color, and texture, and on how contrasting changes in the landscape may affect viewers.

3.11 Scenic Resources

3.11.1 Introduction

This section addresses the existing conditions of scenic resources (including dark skies) in the area of the proposed action and alternatives. It also addresses the potential changes to those conditions from construction and operation of the proposed project. The information contained in this section reflects the analysis information in the process memorandum (Newell and Grams 2018).

Scenery resources are the visible physical features on a landscape; they include land, water, vegetation, animals, structures, and other features. The combination of these physical features creates scenery and provides an overall landscape character. The variety and intensity of the landscape features and the four basic elements—form, line, color, and texture—make up the landscape character. These factors give an area a unique quality that distinguishes it from its immediate surroundings. Usually, if the elements coexist harmoniously, the more variety of these elements a landscape has, the more interesting or scenic the landscape becomes. Scenic quality is the relative value of a landscape from a visual perception point of view.

The scenery resources analysis area (figure 3.11.1-1) lies within the Mexican Highland section of the Basin and Range physiographic province. The province is generally characterized by roughly parallel mountain ranges separated by semi-flat valleys. The analysis area, located at the northern end of the Basin and Range area, includes classic Basin and Range characteristics, with rugged mountains to the north, east, and south, combined with broad basin valleys. Elevations in the area range from 1,520 feet amsl (western terminus of MARRCO corridor) to 5,520 feet amsl (Montana Mountain).

3.11.2 Analysis Methodology, Assumptions, and Uncertain and Unknown Information

3.11.2.1 Analysis Area

We considered the potential viewsheds of different proposed project components and alternatives to develop an overall analysis area for impacts on scenery resources (see figure 3.11.1-1). We based the analysis area on specific distance buffers for the proposed action and alternatives components. We assumed that impacts would be accounted for within these project component buffers.

3.11.2.2 Expected Scenery Changes

Our analysis presents the scenery changes and impacts that we expect based on the mine plans and design, and we present these for each mine component. Further, the analysis includes a qualitative discussion on anticipated changes in contrast between the existing landscape and the proposed activities and facilities. We also discuss the analysis in terms of sensitive viewers in the analysis area. The distance zones and scenery contrast definitions are presented in the accompanying text box. The distance zones differ from those found in the Forest Service Visual Management System (U.S. Forest Service 1974) to reflect the potential views in the desert landscape relative to the scale of the proposed project.

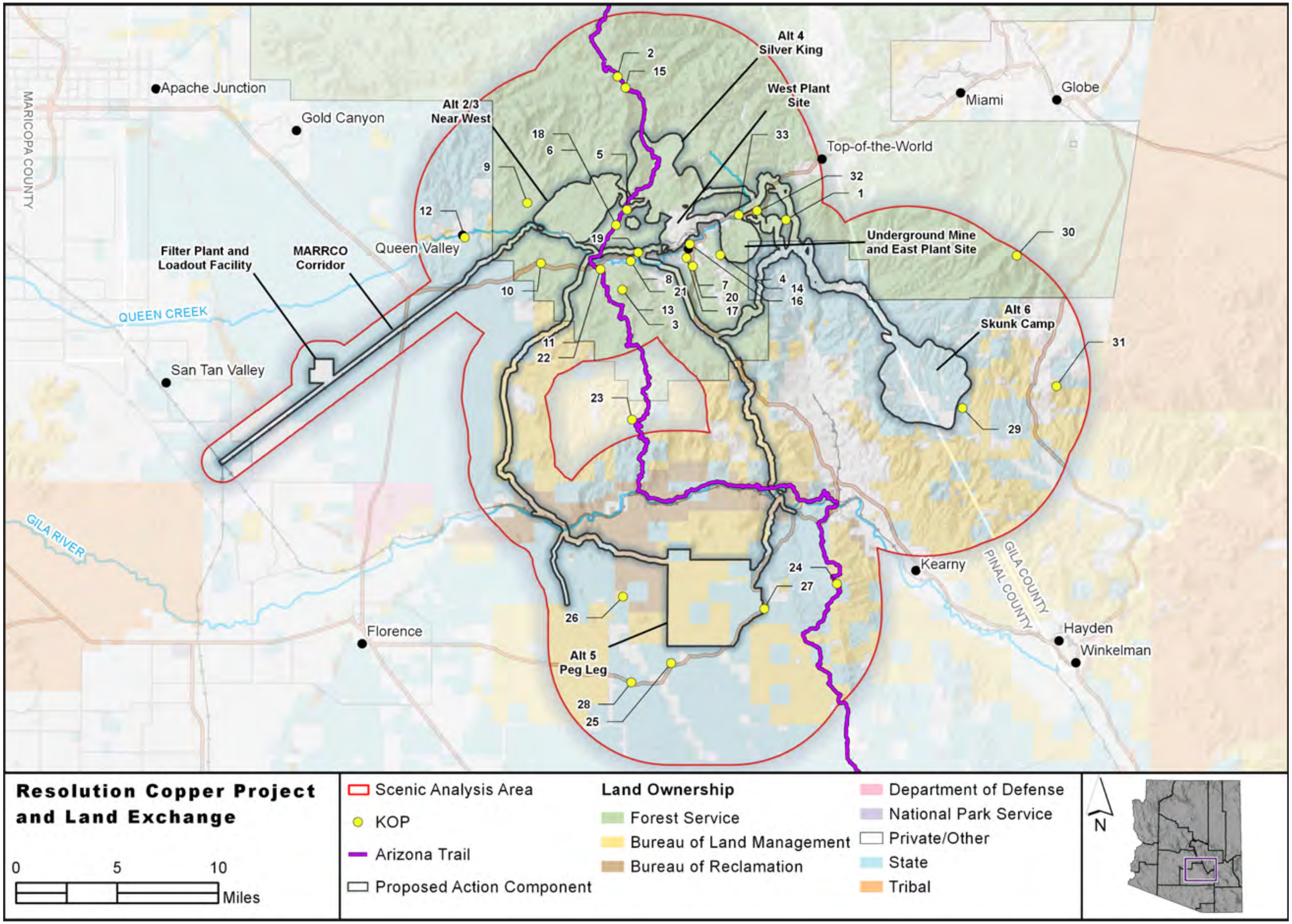


Figure 3.11.1-1. Scenic resources analysis area

Scenery Analysis Area Project Component Buffers
• 6 miles – Tailings facility alternatives
• 2 miles – Slurry pipeline corridor alternatives
• 2 miles – East Plant Site and subsidence area
• 2 miles – West Plant Site
• 2 miles – Transmission lines
• 1 mile – MARRCO corridor
• 1 mile – Filter plant and loadout facility

Distance Zones
Foreground : Up to 1 mile
Middle Ground: 1 to 3 miles
Background: Beyond 3 miles
Contrast Impact Definitions
None: The contrast is not visible or perceived.
Weak: The element contrast can be seen but does not attract attention.
Moderate: The element contrast begins to attract attention and begins to dominate the characteristic landscape.
Strong: The element contrast demands attention, would not be overlooked, and is dominant in the landscape.

3.11.2.3 Viewshed Analysis

The Forest Service and NEPA team developed the viewshed analysis of the tailings facilities for the proposed action and alternatives to illustrate where the facilities would theoretically be visible. We modeled the approximate heights of the tailings facilities and determined, based upon landform and elevation, where the facilities would potentially be visible in the surrounding landscape. The viewshed model does not account for vegetation, structures, and other landscape elements that could obstruct views, but it does provide an approximation of the facility visibility within the analysis area. The viewshed analysis also includes miles of sensitive linear corridors from which the facilities would potentially be visible. The viewshed analyses for each alternative tailings facility are in the process memorandum (Newell and Grams 2018).

3.11.2.4 Key Observation Points and Contrast Rating Analysis

Contrast analysis is a method that measures potential project-related changes to the landscape. The Forest Service and the BLM use this methodology to analyze the impacts on scenic quality and describe landscapes. The method allows for a level of objectivity and consistency in the process and reduces subjectivity associated with assessing landscape character and scenic quality impacts. We used the BLM's Visual Resource Contrast Rating system, as outlined in BLM Manual 8431 – Visual Resource Contrast Rating (Bureau of Land Management 1986a), for the contrast analysis. The system determines the degree to which a proposed project would affect the scenic quality of a landscape based on the visual contrast created between the proposed project and

the existing landscape. The method measures contrast by comparing the proposed project features with the major features in the existing landscape using basic design elements of form, line, color, and texture.

We conducted the contrast rating analysis for 33 key observation points (KOPs) representing sensitive views from residential areas, travel routes, and recreation areas of the proposed action and alternative tailings facilities, transmission lines, and pipeline corridors (see figure 3.11.1-1). The contrast rating worksheets for each KOP are in the process memorandum Newell and Grams (2018). To support the contrast rating analysis and disclose potential visibility of the proposed action and alternative tailings facilities, we provide photographic simulations of the theoretical views of the proposed action and alternatives from the KOPs (Newell and Grams 2018). The simulations are intended to provide a theoretical view of the tailings facilities post-reclamation. We completed most of the simulations with on-site photography. Some simulations were completed using a "block model" process that illustrates the model of the tailings facility with Google Earth imagery.

3.11.3 Affected Environment

3.11.3.1 Relevant Laws, Regulations, Policies, and Plans

Federal

FOREST SERVICE VISUAL MANAGEMENT SYSTEM

The Tonto National Forest Land and Resource Management Plan (1985b) uses the Visual Management System (U.S. Forest Service 1974) for management of forest scenery resources. The Visual Management System establishes Visual Quality Objectives (VQOs) for the forest and designates an acceptable degree of alteration of the characteristic landscape (table 3.11.3-1). This method measures the degree of alteration in terms of visual contrast with the surrounding landscape generated by introduced changes in form, line, color, and texture.

Table 3.11.3-1. Forest Service Visual Quality Objective classification descriptions

VQO Category	Description
Preservation	Allows ecological change only and management activities that are not noticeable to observers. Applies to wilderness areas, primitive areas, other special classified areas.
Retention	Allows management activities that are not evident to the casual forest visitor. Under Retention, activities may only repeat form, line, color, and texture which are frequently in the characteristic landscape. Changes in their qualities of size, amount, intensity, direction, pattern, etc., should not be evident.
Partial Retention	Allows management activities that may be evident to the observer but must remain subordinate to the characteristic landscape. Activities may repeat form, line, color, or texture common to the characteristic landscape but changes in their qualities of size, amount, intensity, direction, pattern, etc., remain visually subordinate to the characteristic landscape.
Modification	Allows management activities that may dominate the characteristic landscape but that must, at the same time, use naturally established form, line, color, and texture. Activities which are predominately introduction of facilities such as buildings, signs, roads, etc., should borrow naturally established form, line, color, and texture so completely and at such scale that their visual characteristics are compatible with the natural surroundings.
Maximum Modification	Allows management activities of vegetative and landform alterations that dominate the characteristic landscape. When viewed as foreground or middle ground, they may not appear to borrow completely from naturally established form, line, color, or texture.

BUREAU OF LAND MANAGEMENT VISUAL RESOURCE MANAGEMENT

The BLM uses the Visual Resource Management (VRM) system to manage visual resources on public lands (Bureau of Land Management 1984, 1986a, 1986b). The VRM system provides a framework for managing visual resources on BLM-administered lands. The four VRM class objectives describe the different degrees of modification allowed to the basic elements of the landscape (i.e., line, form, color, and texture) (table 3.11.3-2).

State of Arizona Scenic Road Designation

Arizona Revised Statutes 41-512 through 41-518 provide for the establishment of parkways, historic roads, and scenic roads. ADOT implements and administers the law. The “Scenic Road” designation includes a roadway (or segment of a roadway) that offers a memorable visual impression, is free of visual encroachment, and forms a harmonious composite of visual patterns. The analysis area contains the Gila-Pinal Scenic Road and the Copper Corridor Scenic Road West, described in section 3.11.3.2.

Local Lighting Ordinances

The Pinal County Outdoor Lighting Code and the Gila County Outdoor Light Control Ordinance contain guidelines and lighting requirements for projects that are proposed in the counties.

3.11.3.2 Existing Conditions and Ongoing Trends

Forest Service and BLM Scenery Management Designations

The number of acres under Tonto National Forest VQO and BLM VRM designations for the scenery resources analysis area are presented in table 3.11.3-3 and illustrated in figure 3.11.3-1.

Table 3.11.3-2. Visual Resource Management class descriptions

VRM Class	Description
I	The objective of this class is to preserve the existing character of the landscape. This class provides for natural ecological changes; however, it does not preclude very limited management activity. The level of change to the characteristic landscape should be very low and should not attract attention.
II	The objective of this class is to retain the existing character of the landscape. The level of change to the characteristic landscape should be low. Management activities may be seen but should not attract the attention of the casual observer. Any changes must repeat the basic elements of form, line, color, and texture found in the predominant natural features of the characteristic landscape.
III	The objective of this class is to partially retain the existing character of the landscape. The level of change to the characteristic landscape should be moderate. Management activities may attract attention but should not dominate the view of the casual observer. Changes should repeat the basic elements found in the predominant natural features of the characteristic landscape.
IV	The objective of this class is to provide for management activities that require major modification of the existing character of the landscape. The level of change to the characteristic landscape can be high. These management activities may dominate the view and be the major focus of viewer attention. However, every attempt should be made to minimize the impact of these activities through careful location, minimal disturbance, and repeating the basic elements of the landscape.

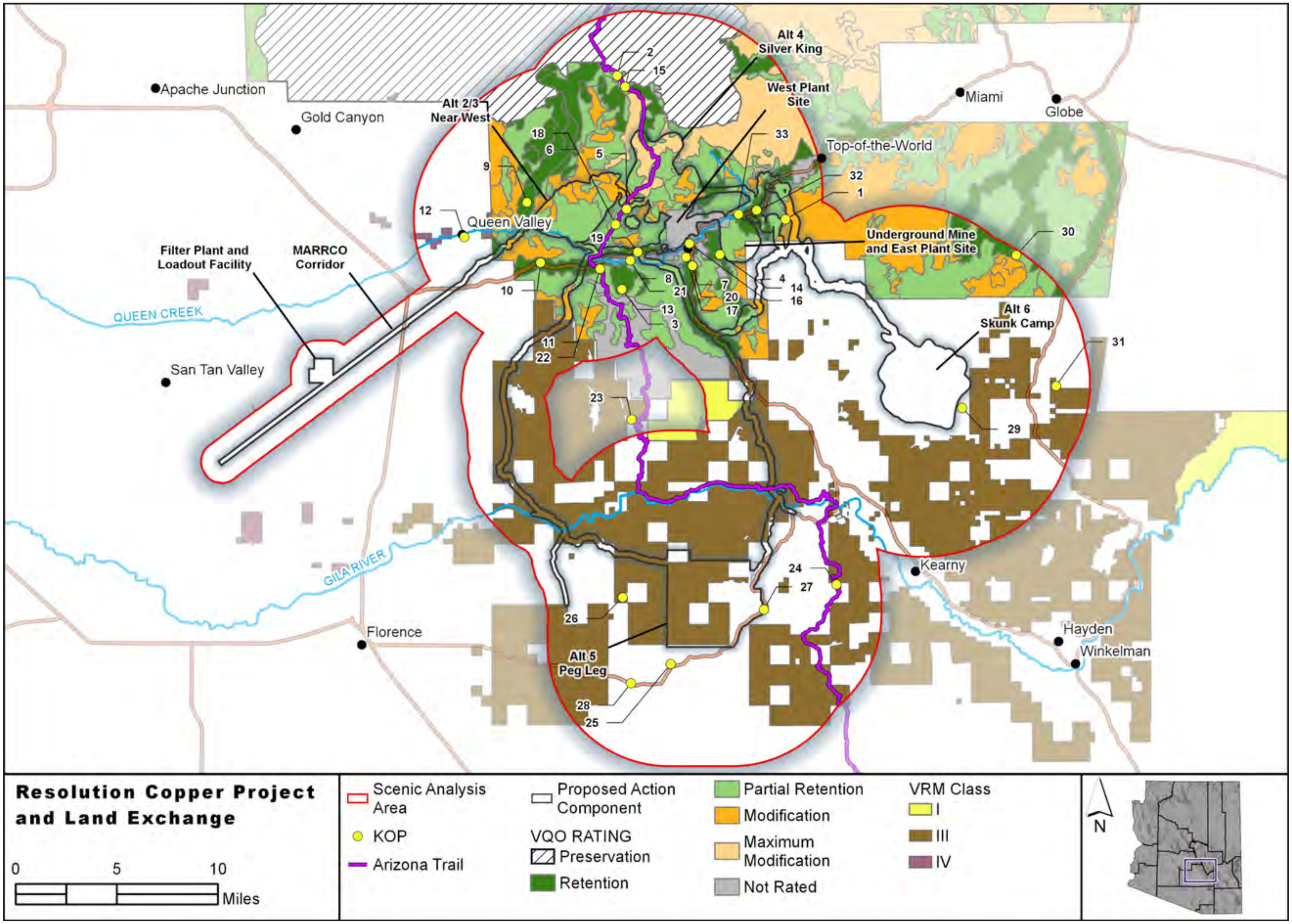


Figure 3.11.3-1. Forest Service and BLM scenery management designations (VQO and VRM)

Table 3.11.3-3. Acreages by scenery management designation

Scenery Designation	Acres
Forest Service VQO	
Preservation	25,410
Retention	26,902
Partial Retention	53,379
Modification	32,638
Maximum Modification	15,014
BLM VRM Class	
Class I	2,607
Class II	0
Class III	124,429
Class IV	738

Scenery Resources in the Analysis Area

The analysis area contains multiple types of scenic resources that could be impacted by construction of the proposed action or alternatives.

- **Arizona National Scenic Trail.** The Arizona Trail extends 800 miles across the state of Arizona from the U.S. border with Mexico to the state of Utah. The trail was designated a National Scenic Trail by Congress in 2009 (U.S. Forest Service 2018a). Approximately 55 miles of the trail—including Passage 15 Tortilla Mountains, Passage 16 Gila River Canyons, Passage 17 Alamo Canyon, and Passage 18 Reavis Canyon—are in the scenery analysis area. The high visual quality of scenery from these passages is diverse and includes steep rocky canyons, high-point vistas, riparian riverways, and developed trailheads and trail facilities. Passage scenery is described in more detail in the process memorandum (Newell and Grams 2018).
- **Apache Leap.** The Apache Leap escarpment is a geographically, culturally, and historically unique feature in the analysis area. The dramatic escarpment visually dominates the eastern skyline from the basin below and provides a scenic backdrop for the town of Superior. Climbers and hikers access the top of Apache Leap by climbing routes and undesignated trail routes. Views from the top of Apache Leap include broad long-distance views of the expansive valley below and more confined views to the east toward the Oak Flat area.

Apache Leap South End parcels, looking east from Donkey Canyon toward the Apache Leap escarpment

- **Picketpost Mountain.** Picketpost Mountain is a prominent mountain feature in the analysis area. At 4,377 feet amsl, it rises dramatically above the valley with rugged geological features and rock cliffs and outcrops. Hikers climb the rugged mountain using undesignated routes. Views from the top of the mountain include broad and expansive views into the valley to the north and views to the south toward the White Canyon Wilderness and the Gila River, including rugged and rolling desert mountains.

Picketpost Mountain, looking east from the Arizona Trail trailhead

- **Superstition Mountains.** The Superstition Mountains are a popular mountain range providing a scenic desert mountain backdrop in the northern portion of the analysis area. They include many heavily used roads and trails. Views from locations in the analysis area include broad and expansive views into the valley below and farther south to Picketpost Mountain and the Gila River valley in the background.
- **Pinal Mountains.** The Pinal Mountains, located south of Globe, Arizona, on the east side of the analysis area, provide popular high-elevation recreation to the surrounding region. Recreationists visit the mountain forest during the hot summer months to enjoy the cooler temperatures. The highest point, Pinal Peak (rising to 7,848 feet amsl), is accessible by dirt road and is frequently visited by recreationists. From Pinal Peak scenic views include background views of the Gila River valley to the east and the wide desert landscapes to the west. Middle ground views include the surrounding Pinal Mountains rugged terrain, including the Dripping Springs Valley.

View overlooking the town of Superior and the West Plant Site

- **Town of Superior, Arizona.** Located in the northern portion of the analysis area, the town of Superior is surrounded by the Tonto National Forest and the natural forest landscape, including Apache Leap and the Superstition Mountains, providing a scenic backdrop to the town. Scenic views from the town include middle ground views of surrounding desert rolling hills and canyons, with background views of rugged mountains, including Apache Leap, Picketpost Mountain, and the Superstition Mountains.
- **Queen Valley, Arizona.** Queen Valley, a residential community located in the eastern portion of the analysis area, lies south and east of the Tonto National Forest. Views of the national forest include background views of rolling desert hills and canyons as well as the rugged and scenic Superstition Mountains.
- **Gila-Pinal Scenic Road (U.S. 60).** The Gila-Pinal Scenic Road is a 35-mile route following U.S. 60 between Forest Junction and Globe, Arizona (Arizona Department of Transportation

2018). The road travels from the western Sonoran Desert habitats through canyons and up to higher ponderosa pine forests in the Globe area. Scenic features along the route include views of the Superstition Mountains, Apache Leap escarpment, the Boyce Thompson Arboretum, Picketpost Mountain, and the town of Superior. The history of copper mining in the region is evident along the eastern portion of the route.

- **Copper Corridor Scenic Road West (U.S. 177).** The Copper Corridor Scenic Road West is a 20-mile route following U.S. 177 between Kearny and Superior, Arizona (Arizona Department of Transportation 2018). The road travels through rugged mountains and river valleys and passes by the vast Ray Mine operations. The Dripping Spring Mountains are on the east side of the road and the White Canyon Wilderness is located to the southwest of the route. Upon the northern approach to Superior, the scenery is dominated by the Superstition Mountains, Apache Leap, and Picketpost Mountain.
- **Florence-Kelvin Highway.** The Florence-Kelvin Highway is a partially paved, partially graded dirt road that extends approximately 32 miles from outside of Florence, Arizona, eastward to U.S. 177. Views along the road include classic Sonoran Desert vegetation of creosote, cholla, ocotillo, and saguaro cactus. Unique rock outcrops appear near the Cochran Road intersection. The road travels northeast and crosses the Gila River, where it joins U.S. 177.
- **Off-Highway Vehicle Recreation Roads.** Dozens of miles of OHV recreation roads are located within the analysis area (see Section 3.9, Recreation, for more detailed information on OHV roads). These roads are used to travel through the Tonto National Forest, BLM-managed lands, and Arizona State Trust lands to visit recreation sites and as scenic tours. Views from these roads include a broad array of scenery, including natural desert rolling hills and canyon, mountain backdrops, and specific scenic features. A heavily used set of OHV roads is located in the northern portion of the analysis area on the Tonto National Forest. The Cochran Road in the southern portion of the analysis area is a popular road on State of Arizona–managed and BLM-managed lands that has views of the White Canyon Wilderness mountains to the north, the Gila River, and an open desert landscape. The Dripping Springs Road, located in the eastern portion of the analysis area, is a moderately used OHV recreation road with views of the Pinal Mountains, rural ranches, and rugged desert rolling hills.
- **Climbing Areas.** Climbing areas are described in detail in Section 3.9, Recreation. The Apache Leap area (described above in this list) represents a climbing area that could be impacted by construction of the proposed action and alternatives, as are the climbing areas located on Oak Flat.
- **Boyce Thompson Arboretum.** The Boyce Thompson Arboretum is located in the northern portion of the analysis area south of U.S. 60. It was established in 1924 and is a popular regional destination with thousands of annual visitors. The arboretum includes a visitor center, demonstration gardens, picnic area, and trails that lead visitors through exhibits of unique vegetation and desert ecosystems. Views from the area range from confined foreground views of rugged rock outcrops, desert vegetation, and canyons to views of expanded vistas of the surrounding Tonto National Forest, Picketpost Mountain, the Superstition Mountains, and Apache Leap.
- **Regional Dark Skies.** Current dark sky conditions in the analysis area are described in the report titled "Impact Assessment of the Proposed Resolution Copper Mine on Night Sky Brightness" (Dark Sky Partners LLC 2018). The report illustrates that current dark sky conditions in the analysis area are influenced by lighting in developed communities and current mining operations. In general, light sources that influence dark skies in the analysis area include the Phoenix metropolitan area (western portion of analysis area), the town of Superior, the Ray Mine, and Florence, Arizona. Specifically,

the study measured current lighting using light-measurement cameras from four locations in the analysis area: Queen Valley, Boyce Thompson Arboretum, town of Superior, and Oak Flat Campground.

Selected Lands

Scenery in the Oak Flat Federal Parcel consists of rolling to steep hillslopes with rounded boulder outcrops, interspersed with high desert vegetation. Background views include the eastern slopes of Apache Leap and the steep and rugged Queen Creek canyon hillslopes. Visitors to Oak Flat Campground, rock climbers climbing the numerous boulder features, OHV recreationists, and hikers represent the sensitive viewers that frequent the Oak Flat Federal Parcel. VQO designations for the Oak Flat Federal Parcel are as follows: Retention—785 acres, Partial Retention—1,416 acres, and Modification—137 acres, with the remaining acres not rated.

3.11.4 Environmental Consequences of Implementation of the Proposed Mine Plan and Alternatives

3.11.4.1 Alternative 1 – No Action

Under the no action alternative, the proposed action or alternatives would not be constructed and therefore no changes to scenery would occur. There would be no impacts on scenic resources.

IMPACTS COMMON TO ALL ACTION ALTERNATIVES

Some components of the project would occur under all action alternatives. The “common to all” components and their associated scenery impacts are described in table 3.11.4-1.

Effects of the Land Exchange

The selected Oak Flat Federal Parcel would leave Forest Service jurisdiction. The role of the Tonto National Forest under its primary authorities in the Organic Administration Act, Locatable Regulations (36 CFR 228 Subpart A), and Multiple-Use Mining Act is to ensure that mining activities minimize adverse environmental effects on NFS surface resources; this includes effects on the scenery resources that occur on the Oak Flat Federal Parcel. The Oak Flat Federal Parcel would become private at the completion of the NEPA process, and the current VQOs (Retention, Partial Retention, Modification), which provide protection to scenery resources, would be removed. The Forest Service would not have the ability to require mitigation for effects on scenery resources on the lands; thus, effects on scenery could be greater than if the parcel retained the VQO designation.

The offered lands parcels would come under Federal jurisdiction. Specific management of the scenery resources of those parcels would be determined by the agencies to meet desired conditions or support appropriate land uses. In general, these parcels contain a variety of scenery resources similar to those found in the analysis area, that would come under Federal jurisdiction.

Effects of Forest Plan

The Tonto National Forest Land and Resource Management Plan (1985b) provides guidance for management of lands and activities within the Tonto National Forest. It accomplishes this by establishing a mission, goals, objectives, and standards and guidelines. Missions, goals, and objectives are applicable on a forest-wide basis. Standards and guidelines are either applicable on a forest-wide basis or by specific management area.

A review of all components of the 1985 forest plan was conducted to identify the need for amendment due to the effects of the project, including both the land exchange and the proposed mine plan (Shin 2019). A number of standards and guidelines were identified as applicable to management of scenery resources.

Table 3.11.4-1. Impacts on scenic resources common to all action alternatives

Mine Facility and Phase	Visual Impact Assessment
East Plant Site Facilities	
Construction	Visual disturbance from construction equipment movement and activity, fugitive dust, and overall change in contrast in form and color from the existing landscape would occur. Areas in the East Plant Site vicinity that remain open to future public visitation are limited. Because of this and the landscape topography, the East Plant Site would be visible from a limited number of locations on the national forest; primarily, visibility would be from high points to the east on NFS Road 2466, approximately 2.5 miles from the East Plant Site. The visual dominance of construction would be short term with intensity of views varying based upon distance and topography, resulting in overall moderate impact on scenery.
Operations	Long-term impacts on scenery would result from a change in contrast from existing landscape conditions from new development. Because of existing facility development at the East Plant Site and the limited visibility from the area, the anticipated change in contrast is moderate. The scenery impact would be long term in duration; however, visual dominance and intensity of scenery impacts would be reduced as a result of limited visibility from sensitive viewers.
Closure and Reclamation	Mine facilities at the East Plant Site would be largely removed, and the area would be reclaimed to natural conditions to the maximum amount possible. Headframes and hoists and some roads would remain in place for use in post-closure groundwater monitoring. Long-term visual dominance and intensity from development of the East Plant Site to the scenery would move from moderate to minor with increased site revegetation and successful site reclamation.
Subsidence Area	
Operations	Subsidence breakthrough is anticipated to begin at approximately mine year 12. Subsidence would expand slowly to the maximum width and depth at approximately mine year 47. As described earlier in this section, because of limited public access and visibility, visual dominance from changes in form, line, color, and texture of the subsidence area would be limited to small portions of the adjacent Tonto National Forest. KOP 1 (NFS Road 2466, east of the subsidence area) illustrates long-term scenery impacts from subsidence. The visual simulation shows the anticipated change in contrast from the existing landscape expected from ground subsidence (Newell and Grams 2018). Because of distance and angle of view to the subsidence area, the anticipated visual dominance and intensity to scenery from this KOP is weak (visible, but does not attract attention). Figure 3.11.4-1 presents a visual simulation of anticipated subsidence at end of mining from an aerial perspective using Google Earth imagery.
Closure and Reclamation	At the end of mine operations, a fence or berm would be constructed around the continuous subsidence area and no reclamation activities, including revegetation, would occur because of safety hazards. Long-term impacts on scenery would remain weak from KOP 12. Views of the subsidence area are most accessible from the elevated viewpoints in the air. Visualizations of the subsidence area from these elevated viewpoints that illustrate the different fracture zones are presented in the visual simulation package (Newell and Grams 2018). Visual dominance and intensity impacts on views from the air would be strong; however, there would be very few people viewing from this angle and elevation.

continued

Table 3.11.4-1. Impacts on scenic resources common to all action alternatives *(cont'd)*

Mine Facility and Phase	Visual Impact Assessment
West Plant Site Facilities	
Construction	Impacts on scenery in the area would result from the construction activity, including heavy equipment operation, traffic and heavy truck transportation, fugitive dust from ongoing land disturbance, and power line construction. Areas within 2 miles of the West Plant Site could be impacted by construction activities by a change in landscape form, line, color, and texture and the dominance of new landscape features in the view. This area includes the town of Superior and recreation roads on the Tonto National Forest. The overall impact on scenery from these construction activities would be strong because of the visual dominance related to changes in form, line, color, and texture, and intensity of views in the landscape foreground.
Operations	During operations, impacts on scenery would continue to be strong within 2 miles of the area.
Closure and Reclamation	Mine operation facilities would be largely removed and the area would be reclaimed to natural conditions to the maximum amount possible. Some facilities and roads would remain to support long-term monitoring at the site. Visual dominance and intensity of impacts, after facility removal and successful restoration and revegetation, would potentially go from strong to moderate, depending upon reclamation success. Because of the scale of the facility ground disturbance, the site contrast would likely remain visible for many years post-reclamation.
Transmission Lines	
3.5-mile 230-kV line from existing Silver King substation to new Oak Flat substation at East Plant Site. Follows existing line.	Construction: Scenery impacts from construction activities would include active construction equipment and traffic, land clearing, and fugitive dust emissions. Construction activity visual disturbances would temporarily impact viewers adjacent to the transmission corridors. Travelers on Gila-Pinal Scenic Road (U.S. 60) would view transmission line construction activities, specifically in areas where the line is directly adjacent to and crossing over the highway in the steep, rocky section of the highway near the East Plant Site. Operations: The upgraded towers and wires would be visible from the Gila-Pinal Scenic Road (U.S. 60). Although there is an existing line in this corridor, the new adjacent line would be larger and more visible than the existing line. Depending upon the angle of view and exact locations of the transmission towers, the contrast would range from moderate to strong. In areas where the transmission line has potential to "skyline" (i.e., to be visible on high landscape features with sky in the background), the transmission line would present strong contrast. In areas where there are landscape features in the background of the view, contrast would be moderate. Where the transmission line corridor crosses U.S. 60 near the East Plant Site, the structures would present a strong contrast, depending upon their siting relative to the steep canyon walls. Visual dominance and intensity, related to changes in form and line would be increased relative to the existing transmission lines in the corridor, particularly in the Oak Flat area along U.S. 60. KOP 33 (U.S. 60 transmission lines) illustrates scenery impacts from transmission line construction in the vicinity of Oak Flat on U.S. 60 and shows the anticipated change in contrast relative to the existing landscape expected from transmission line operation ((Newell and Grams 2018). The new transmission line would dominate the view for sensitive viewers traveling on U.S. 60, the designated Gila-Pinal Scenic Road. The transmission line also would present strong contrast and visual dominance relative to the existing landscape from changes in line and color from the wires and poles at the top of the canyon walls. Closure and Reclamation: The closure and reclamation plan for the transmission facilities is currently unknown. If a post-mining use for the power facilities and transmission lines is identified, the facilities would remain on the landscape. If not, the structures would be removed and the area reclaimed.

continued

Table 3.11.4-1. Impacts on scenic resources common to all action alternatives *(cont'd)*

Mine Facility and Phase	Visual Impact Assessment
3.5-mile 230-kV line from new Oak Flat substation (East Plant Site) to new West Plant Site substation.	Construction: General construction impacts are the same as described above. This line segment also is adjacent to and crosses the Gila-Pinal Scenic Road (U.S. 60) and would have similar impacts on that area. This segment traverses the hills above the town of Superior and is approximately 0.5 to 1.0 mile from the community. Construction disturbance could temporarily impact scenery resources in the town, including operation of construction equipment and fugitive dust.
New line.	Operations: Operations impacts are similar to those described above. The new towers and wires would be visible from the town of Superior and in areas where the angle of view creates “skylining,” and where new roads are constructed the contrast would be strong. In areas without new road construction and where the line contrast is absorbed by a landscape background, the contrast would range from moderate to weak.
	Closure and Reclamation: Same as described above.
Tailings Facility	
Construction	General construction impacts on scenery resources for each tailings facility alternative would be similar. During initial tailings facility development (mine years 0 to 6), activities would include construction of perimeter fencing, access roads, drainage control structures, containment ponds, monitoring wells, and an office and equipment storage facility. Construction of these facilities would impact scenery resources in the area surrounding the tailings in the foreground, middle ground, and background through facility development and ground disturbance. Large areas of ground disturbance, vegetation removal, and fence construction would create a strong change in contrast with the background landscape that would be visible by a range of viewers extending from the foreground to the background (beyond 3 miles). Viewers in the vicinity would be impacted by the change in contrast created by land disturbance and vegetation removal, fugitive dust emissions from traffic and land-disturbing activities, and construction equipment operation, and the impact on these users would be strong (demands attention). The tailings facility would dominate long-term views in the vicinity of the tailings facility from intense changes in form, line, color, and texture related to the existing landscape.
Operation	General operation impacts on scenery resources for each tailings facility alternative would be similar. The facility would slowly grow to the full facility. Prior to reclamation activities, as the embankment grows, the facility would become increasingly visible from sensitive viewpoints in the region surrounding the tailings facility. In general, the tailings facility would become more and more visible over time, and the color of the tailings stockpile would be a medium gray color. Concurrent reclamation activities vary and are described for each alternative. The tailings facility would dominate long-term views in the vicinity of the tailings facility with increasing intensity as the facility grows and dominates the view with changing form, line, color, and texture.
Closure and Reclamation	The tailings facility would be revegetated during closure and reclamation. Contrast would be reduced as vegetation grows on the tailings embankment faces and other parts of the facility. Contrast would continue to be strong in the middle ground and foreground after revegetation because of the change in landform. The tailings facility would continue to dominate the views of the landscape with obvious difference in form, line, color, and texture from the surrounding landscape.

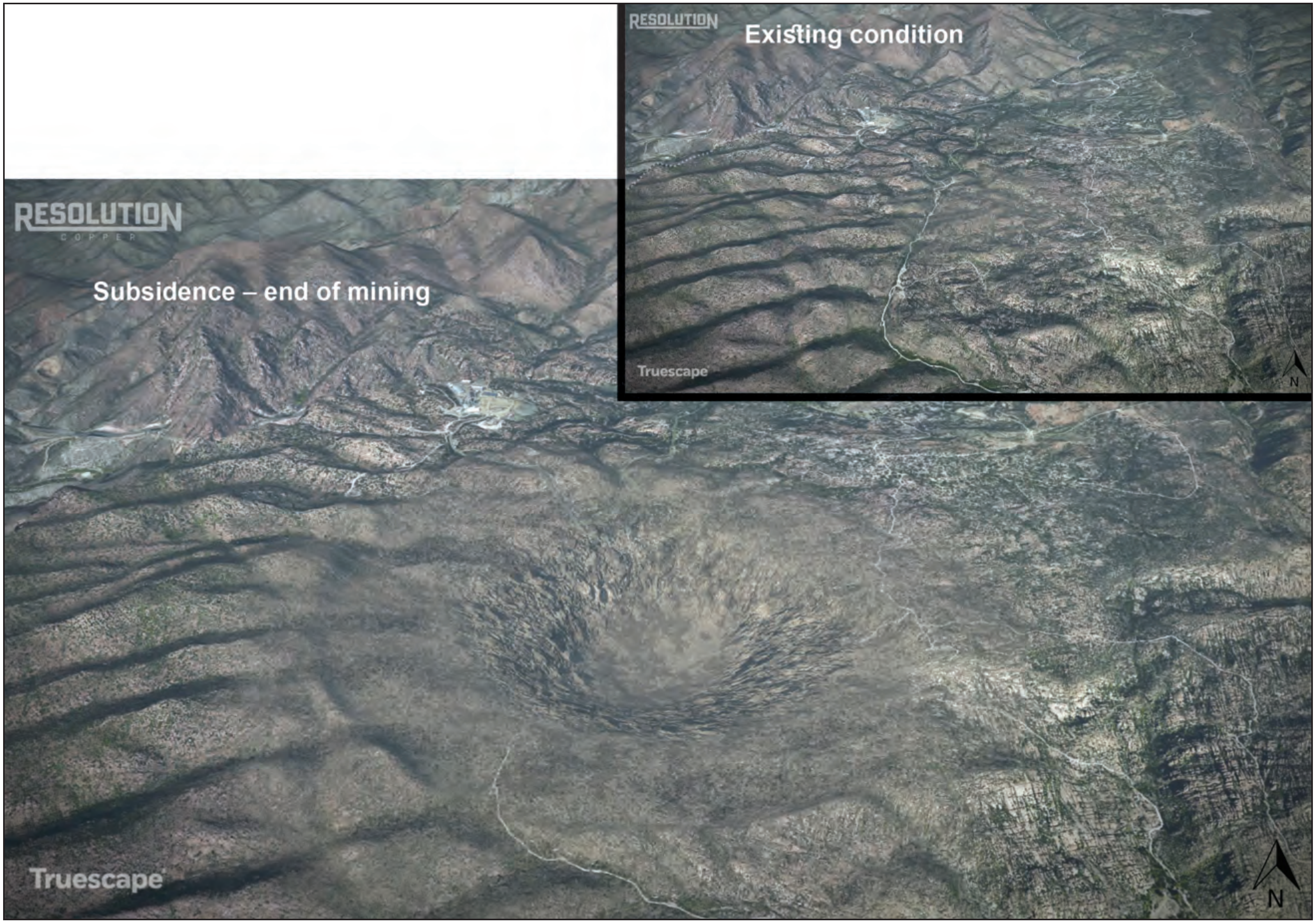


Figure 3.11.4-1. Subsidence area visual simulation from aerial perspective at end of mining using Google Earth imagery

The project would have effects on the scenery resources within the Tonto National Forest by modifying the current forest plan VQO designations. In general terms, Retention and Partial Retention do not allow for the proposed project activities as a whole. Retention requires that activities be "not visually evident." Partial Retention requires that activities be "visually subordinate" to the characteristic landscape. The Modification designation allows for activities to visually dominate the original character of the landscape, but vegetation and landform should mimic the natural landscape. With adequate mitigation, including revegetation, the project as proposed could meet the Modification designation. Implementation of the project would require amending the forest plan by changing the areas designated Retention and Partial Retention to the Modification VQO category.

Table 3.11.4-2 lists the VQO designation acres for each alternative within each of the affected management areas. It presents the total acres for Retention and Partial Retention that would be changed to Modification by alternative and the percentage change in acreage for each category in the scenery resources analysis area.

Applicant-Committed Environmental Protection Measures

A number of environmental protection measures are incorporated into the design of the project that would act to reduce potential impacts on scenic resources. These are non-discretionary measures and their effects are accounted for in the analysis of environmental consequences.

Applicant-committed environmental protection measures by Resolution Copper include those outlined in the dark skies analysis (Dark Sky Partners LLC 2018):

- Implement an outdoor lighting plan that would reduce potential impacts from artificial night lighting.
- Reduce illumination levels where appropriate while still meeting MSHA requirements for lighting sufficient to provide safe working conditions.
- Adhere to the Pinal County Outdoor Lighting Code.
- Use control systems that can turn off lights at particular times of night or are activated by detecting motion while still meeting MSHA requirements for lighting sufficient to provide safe working conditions.

Additional applicant-committed environmental protection measures by Resolution Copper include the following:

- Use non-reflective earth-tone paints on buildings and structures to the extent practicable.
- Bury concentrate pipelines to the extent practicable. Concentrate pipelines will have approximately 3.3 feet (1 m) of cover over buried sections. See detailed concentrate pipeline protection plan for further information.
- Build rust colored towers or use wooden poles on transmission lines.
- Use shafts constructed of rust colored metal headframes that blend with the scenery.
- Bury tailings and other pipelines to the extent practicable.
- Perform concurrent reclamation of tailings embankment beginning at approximate year 10 of tailings operations.
- Use a reclamation seed mix of weed-free native species consistent with surrounding vegetation.
- Build concentrator building behind mountain terrain to screen views from the town of Superior.
- Use colors that blend in with the desert environment.

Table 3.11.4-2. Scenery management designations by management area and alternative (acres)

Management Area/VQO	Alternatives 2 and 3	Alternative 4	Alternative 5 (East)	Alternative 5 (West)	Alternative 6 (North)	Alternative 6 (South)
MA 2F						
Retention*	**343**	**343**	**663**	**502**	**648**	**743**
Partial Retention*	**2,413**	**4,583**	**1,825**	**1,744**	**1,963**	**2,145**
Modification	523	1,159	203	352	573	511
Maximum Modification	0	1,847	0	0	0	0
MA 3I						
Retention*	**50**	**28**	**28**	**28**	**28**	**28**
Partial Retention*	**2,771**	**80**	**80**	**80**	**80**	**80**
Modification	1,182	19	19	19	19	19
Maximum Modification	0	0	0	0	0	0
Acres of VQO changed from Retention and Partial Retention to Modification for both management areas	**5,577**	**5,034**	**2,596**	**2,354**	**2,719**	**2,996**
Percent Change (decrease) of Retention and Partial Retention†	**−6.9**	**−6.3**	**−3.2**	**−2.9**	**−3.4**	**−3.7**
Percent Change (increase) in Modification†	**17.1**	**15.4**	**8.0**	**7.2**	**8.3**	**9.2**

* Under the action alternatives, these Retention and Partial Retention acreages would change to a Modification management designation.

† Calculated using data from table 3.11.3-3. Total acres in analysis area for Partial Retention and Retention equals 80,281, and Modification equals 32,638.

Table 3.11.4-3. Impacts on scenic resources under Alternative 2

Mine Facility and Phase	Visual Impact Assessment
Tailings Pipeline Corridor	
Construction	Impacts on the area scenery from construction activities would affect sensitive users on the Arizona Trail (Passage 18 Reavis Canyon) and NFS OHV roads in the vicinity of the pipeline corridor (up to 2 miles). The corridor crosses NFS Road 650, a popular OHV road. NFS Road 982 parallels the corridor near the Arizona Trail and provides access to this area near the western end of the pipeline corridor. Scenery impacts from construction activities on these users would include fugitive dust from ground disturbance, and visual disturbance from construction equipment, including construction vehicles accessing the area on NFS Roads 650 and 982. For forest users in the vicinity of the construction activities, impacts on scenery would be strong.
Operations	Impacts on scenery would result from linear mine support facilities in the corridor causing a strong change in contrast with the existing landscape. A strong contrast from vegetation removal in the 150-foot-wide corridor would be visible from 2 miles or more, depending on the vantage viewpoint. The 34.5-kV transmission line following the corridor would include approximately 35-foot-tall transmission line structures. The structures would present strong contrasting horizontal and vertical lines from associated towers and wires. Long-term visual dominance from prominent changes in form and line would occur in areas where recreation facilities cross the corridor. Impacts on sensitive viewers using OHV roads in the vicinity of the tailings would occur in areas where the roads cross or are parallel to the corridor. KOP 5 (Arizona Trail Barnett Camp) was established to illustrate long-term scenery impacts on the Arizona Trail from the tailings pipeline corridor. The visual simulation presents views of the elevated pipeline bridge from the Arizona Trail in the Barnett Camp area approximately 800 feet from the facilities (Newell and Grams 2018). The bridge presents dominant contrasting horizontal and vertical lines in light and dark gray colors in the foreground of the view. The pipeline bridge would dominate the view from this KOP for the long term with strong visual contrast (demands attention and is dominant in the landscape).
Closure and Reclamation	The tailings corridor and associated infrastructure would be removed and the corridor area would be regraded to mimic the natural condition and planted with native vegetation. Long-term impacts on scenery would be expected to persist because revegetation of disturbed landscapes in this type of desert ecosystem is difficult. The tailings corridor would likely be visible and present a permanent linear corridor contrast across the background landscape. Initial scenery impacts would be strong and would potentially reduce to moderate as vegetation growth increases in the corridor over many years. Intensity and dominance of the corridor form and line in the scenic landscape would be reduced over time.

continued

Table 3.11.4-3. Impacts on scenic resources under Alternative 2 *(cont'd)*

Mine Facility and Phase	Visual Impact Assessment
MARRCO Corridor	
Construction	Temporary impacts on scenery from construction equipment operation and traffic, facility construction, land disturbance, and fugitive dust emissions would occur. Sensitive viewers in the area around the MARRCO corridor include travelers on U.S. 60, Queen Valley Road, Hewitt Station Road, OHV roads in the vicinity, and hikers on the Arizona Trail (Passage 18 Reavis Canyon). These areas close to the corridor would experience strong contrast (demands attention) from the construction activities. This impact would be temporary as construction activities moved down the corridor. The construction activities would dominate landscape views for sensitive viewers in the foreground with changes in form, line, and color.
Operations	New facilities in the MARRCO corridor would result in a change in scenery contrast in areas adjacent to the facilities. Although the corridor is currently disturbed, the addition of several pipelines and road improvement would increase the visual contrast to a moderate to strong level because of the change. Sensitive areas in the vicinity include the Arizona Trail as it parallels and then crosses the corridor, Hewitt Station Road and a portion of Queen Valley Road, and the Gila-Pinal Scenic Road (U.S. 60). Moderate to strong changes in contrast would result. Facilities in the corridor would introduce changes in form, line, and color that would create long-term dominant changes in the landscape.
Closure and Reclamation	The closure and reclamation plan for the MARRCO corridor facilities and utilities is unknown at this time. It is known that the copper concentrate lines would be removed and the area around the lines recontoured and revegetated. Other facilities, including transmission lines, water lines, and the upgraded railroad facility, may be left in place. The impact on scenery in the area around the facilities would continue to be moderate to strong.
Filter Plant and Loadout Facility	
All mine phases	Impacts on scenery would be from construction equipment operation and traffic, facility construction, fugitive dust emissions, and rail line traffic on-site. However, sensitive viewers in the area around the facility are few as the parcel is isolated, and impacts on viewers and scenery in the area would therefore be minimal. Overall impacts on scenery would be weak.

3.11.4.2 Alternative 2 – Near West Proposed Action

Impacts on scenery specific to Alternative 2, in addition to the impacts common to all action alternatives (see table 3.11.4-1), are described in table 3.11.4-3.

Tailings Facility

Sensitive viewers in the foreground (within 1 mile) under Alternative 2 that would be impacted are users of the Arizona Trail (Passage 18 Reavis Canyon) and OHV users on the area NFS roads (Hewitt Station Road, NFS Roads 982, 1904, 1903). These users would be impacted by the change in contrast created by land disturbance and vegetation removal, fugitive dust emissions from traffic and land-disturbing activities, and construction equipment operation, and the impact on these users would be strong (demands attention). The scope and scale of the tailings facility would visually dominate the existing landscape features and scenery with highly visible, long-term changes in landscape form, line, color, and texture. During mine operations, the tailings facility would slowly grow to the full facility size of approximately 4,864 acres and 520 feet high. The tailings embankment would be constructed at a 4H:1V slope and reclamation/revegetation of the embankment would begin in approximately mine year 28.[68] Concurrent reclamation (beginning in mine year 28) would begin to reduce the contrast as vegetation grows on the tailings embankment faces.

Viewshed Analysis. The viewshed for Alternative 2 is presented in the process memorandum (Newell and Grams 2018). It illustrates the general visibility of the tailings facility across the landscape within the analysis area and shows the high points and location where the facility could be most visible. Viewshed analysis for the linear features in the analysis area is presented in table 3.11.4-4.

KOP Scenery Analysis. The Forest Service and NEPA team identified sensitive viewpoints around the tailings facility to analyze impacts on the area's scenery resources (see figure 3.11.1-1). An Alternative 2 impact summary for these KOPs is presented in table 3.11.4-3. The contrast rating analysis process (described in section 3.11.2.4) was conducted for each KOP and is presented in table 3.11.4-5. More detail on the KOPs, along with the related contrast rating worksheets and the visual simulations, is provided in the process memorandum (Newell and Grams 2018).

Dark Skies

The proposed mining activities under Alternative 2 would increase lighting at the East Plant Site, West Plant Site, and tailings facility, which would impact current dark sky conditions in the analysis area; see "Impact Assessment of the Proposed Resolution Copper Mine on Night Sky Brightness" (Dark Sky Partners LLC 2018). The report states,

> When considering the areas of the sky in directions toward the proposed RC facilities, the proposed RC lighting will increase sky brightness between 40% and 160%. Such increases are likely to be obvious to even casual observers. (Dark Sky Partners LLC 2018)

Based on this analysis, the mine operation facilities would be visible and noticeable at night from the town of Superior, U.S. 60, Boyce Thompson Arboretum, the Arizona Trail, and the surrounding national forest landscape. The GPO states that exterior lighting would be kept to the minimum required for safety and security purposes and that lighting would be directed downward and hooded where practicable.

The mine facility lighting plan would comply with the Pinal County Outdoor Lighting Code as long as mine safety and operations are not compromised and there are not conflicts with MSHA regulations (M3 Engineering and Technology Corporation 2019a). The mine facilities would be regulated by the code's Lighting Zone 3 (the most restrictive

68. There is a possibility that the embankment could be constructed at a 3H:1V slope rather than the steeper 4H:1V slope as designed and that reclamation could begin approximately in mine year 22; this analysis assumes the steeper slope and later commencement of reclamation.

Table 3.11.4-4. Viewshed analysis for linear features (roads and trails) in Alternative 2

Linear Viewshed Component	Total Miles in Analysis Area	Total Miles within Viewshed	Scenery Impact Discussion
U.S. 60	32.5	21.2	Views of the facility would vary and would depend on landscape feature such as structures and vegetation. Visible locations closest to the facility would be most impacted and would have strong to moderate changes in contrast relative to distance, angle of view, and potential visual obstructions. The tailings facility would visually dominate views, compared with the existing landscape, as a result in changes in form, line, and color. The intensity and dominance would be greater in areas in the foreground and middle ground with unobstructed views. Specific views from the road are described in the KOP analysis in table 3.11.4-5.
SR 177	2.9	2.5	Although the viewshed illustrates that the tailings facility would be visible from a majority of the road, landscape features such as structures and vegetation could obstruct some views. With distance to the facility ranging from 4.75 to 5 miles, the tailings feature would appear in the background landscape when visible. Visual dominance would be minimal because changes in form, line, and color would be less visible due to the distance to the tailings facility. Specific views from the road are described in the KOP analysis in table 3.11.4-5.
Arizona Trail	23.0	11.0	For persons traveling on the Arizona Trail, scenic views would be impacted by the proposed tailings facility. As described above, landscape features may obstruct views. The tailings facility would visually dominate views, compared with the existing landscape, as a result in changes in form, line, and color. The intensity and dominance would be greater in areas in the foreground and middle ground with unobstructed views. Specific views along the trail are described in the KOP analysis in table 3.11.4-5.

Table 3.11.4-5. Alternative 2 key observation point descriptions and contrast rating analysis

KOP Number	KOP Name	View Description and Contrast Rating Analysis
1	NFS Road 2466 east of subsidence area	Analysis presented earlier in this section under the subsidence operation analysis in *table 3.11.4-3*.
2	Arizona Trail northwest of Montana Mountain*	The tailings facility would be visible from this location and would present a change in contrast ranging from moderate to strong. As the facility grows, contrast would increase with the strongest contrast presented at the end of mining operations, but before closure and reclamation is complete.
3	Picketpost Mountain*	The tailings facility would be highly visible from this KOP and would present prominent changes in the middle ground and background views in form, line, color, and texture. The changes would result in strong contrast.
4	Apache Leap*	The tailings facility would be moderately visible from this KOP and would present changes in background views in line and color. The changes would result in moderate contrast because the distance and angle of view of the facility would potentially blend with the background landscape.
5	Arizona Trail – Barnett Camp[†]	Analysis presented earlier in this section under the tailings corridor operation analysis in *table 3.11.4-3*.
6	Arizona Trail – Ridge[†]	The facility would be located in the foreground and middle ground views of the KOP and would present a strong change in form, line, color, and texture in the landscape. As the facility develops, it would become increasingly visible due to the changes in landscape color and form, with the facility presenting a gray tone and new line features within the rolling terrain. The facility would be most visible prior to commencement and implementation of successful concurrent reclamation activities. It is anticipated that concurrent reclamation would begin to mitigate visual contrast in approximately mine year 30.
7	SR 177 from Kearny[†]	Because of distance and angle of view, the tailings facility would be minimally visible to persons traveling on SR 177. The change in contrast in form and color would be weak.
8	Picketpost House – (Boyce Thompson Arboretum)[†]	The tailings facility would be visible in the KOP's middle ground view. Prior to concurrent reclamation activities, contrast would be moderate to strong for changes in form, line, and color in the landscape. The facility's gray color would be visible from the KOP. Upon implementation of successful concurrent reclamation, the contrast would be reduced to moderate.
9	NFS Road 172[†]	The tailings facility would be visible in the foreground to middle ground of this KOP. Impacts on scenery are similar to the discussion presented for KOP 6.
10	U.S. 60 Milepost 21[9†]	The tailings facility would be visible in the middle ground and background views of the KOP. As the tailings facility grows, it would become increasingly visible from this KOP because of the color, line, and form changes in the landscape. The facility would be most visible prior to successful concurrent reclamation. The contrast would be strong but could become moderate with successful concurrent reclamation. The visual simulation for KOP 10 is presented in figure 3.11.4-2.

continued

Table 3.11.4-5. Alternative 2 key observation point descriptions and contrast rating analysis *(cont'd)*

KOP Number	KOP Name	View Description and Contrast Rating Analysis
11	Arizona Trail at Picketpost Trailhead†	The tailings facility would be visible in the middle ground view of the KOP. Existing terrain features and angle of view reduce the visibility and noticeability of the facility from trail users. Changes in contrast would be weak to moderate prior to concurrent reclamation and potentially weak after successful reclamation.
12	Queen Valley, North Charlotte Street†	The tailings facility is minimally visible within the background views of the KOP. The terrain features a low saddle between higher hills in the background. A small part of the highest portion of the tailings facility would be visible from this KOP. However, it would not be noticeable to the casual viewer, and the anticipated change in contrast from this location is weak.

* Block model Google Earth visual simulation

† Photograph visual simulation

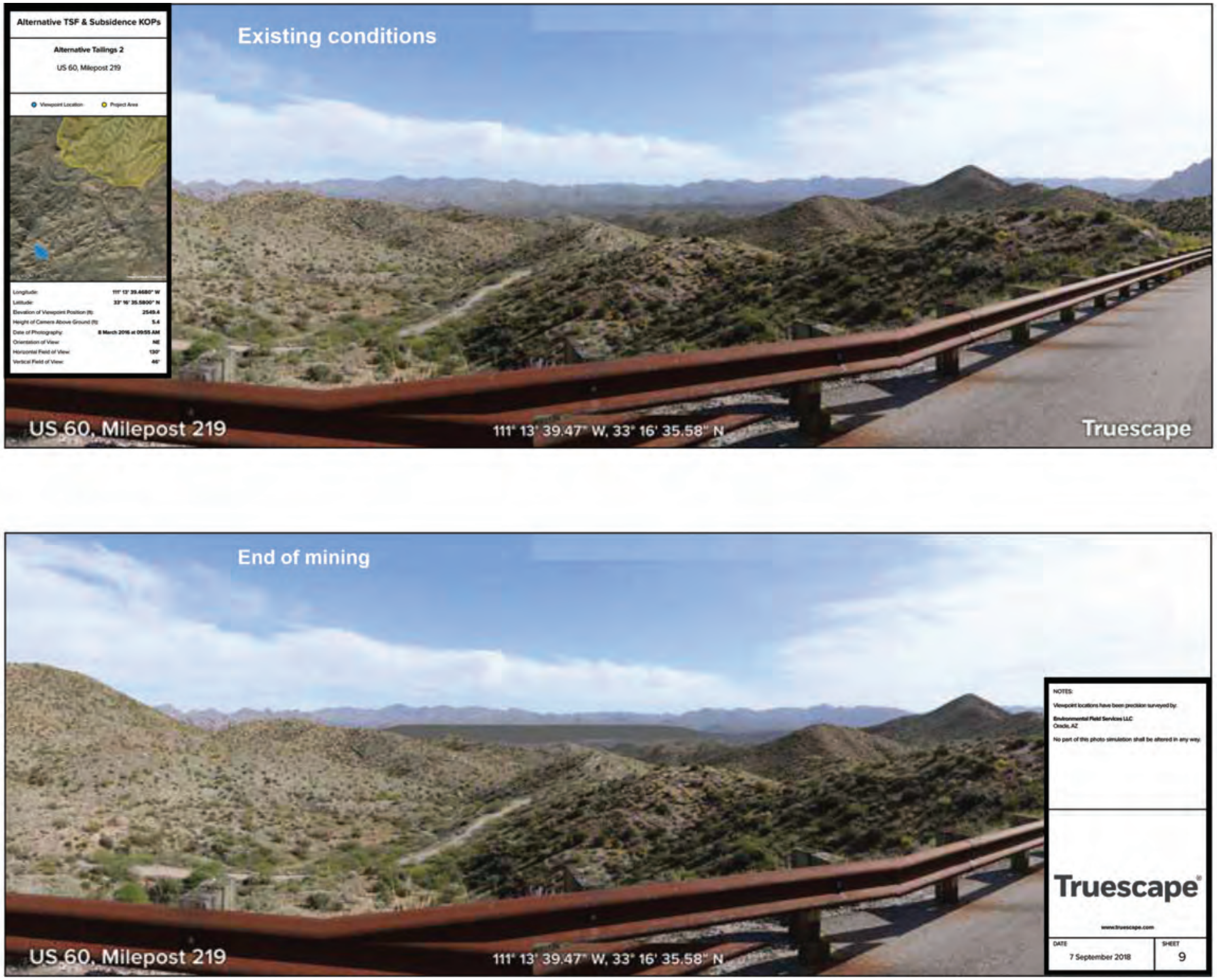


Figure 3.11.4-2. Visual simulation of Alternative 2 tailings facility from KOP 10 – U.S. 60 Milepost 219

zones) that allows the maximum lumen density (amount of light) as 19 lumens per square foot from all light sources.

3.11.4.3 Alternative 3 – Near West – Ultrathickened

The differences in impacts on scenery between Alternatives 2 and 3 are described in the following text.

Tailings Facility

Unlike the proposed action that includes concurrent reclamation of the tailings facility beginning in mine year 28, Alternative 3 would not include concurrent reclamation activities. Reclamation of the tailings embankment face would not occur until construction of the tailings embankment face is complete at the end of mining operations (mine year 46). Under Alternative 3, the tailings facility would present strong contrast in the region's scenery for all sensitive viewers for approximately 20 additional years, compared with Alternative 2. The scope and scale of the tailings facility would visually dominate the existing landscape features and scenery with highly visible, long-term changes in landscape form, line, color, and texture. The tailings facility would create a strong contrast in the landscape that would increase over many years, with the strongest contrast occurring when the mining operations are complete (mine year 46) and successful reclamation has occurred at the facility (approximately mine year 50 to 55).

Dark Skies

General impacts on the area's night skies would be the same as described under Alternative 2.

3.11.4.4 Alternative 4 – Silver King

The differences in impacts on scenery between Alternatives 2 and 4 are described in the following text.

West Plant Site

Under Alternative 4, the filter plant and loadout facility would be moved to the West Plant Site. However, the addition of this facility would result in generally the same scenery impacts as presented in "Impacts Common to All Action Alternatives" earlier in this section.

Tailings Pipeline Corridor

Tailing slurry would be delivered from the West Plant Site to the Silver King tailings facility via pipelines approximately 1.5 miles long. General impacts on scenery related to pipeline construction are described under Alternative 2. Under Alternative 4, an overall reduction in the length of tailings slurry pipeline, a consolidation of mine operations facilities, and reduced footprint would result in reduced impacts on scenery from tailings pipeline construction and operation.

Tailings Facility

Although there are differences between the proposed action tailings facility and the Silver King tailings facility in terms of design and processing, general scenery impacts from the two are the same as described under "Impacts Common to All Action Alternatives" and Alternative 2. Additions of two filter plants, mechanical conveyers, and emergency slurry overflow ponds, while adding to the facilities, would not change the general impacts described previously. However, the Silver King facility would be the tallest at over 1,000 feet in height and approximately double the height of the Alternative 2 and 3 facilities. The height of the facility increases the visual dominance of the overall form in the existing canyon landscape and increases visibility from sensitive viewing locations.

Reclamation and contouring of the filtered tailings would occur concurrently during mining operations. However, it is unknown at this time what year the concurrent reclamation would occur. Assuming it is similar to the reclamation timing under Alternative 2 (concurrent reclamation beginning in mine year 28) impacts would be same as described earlier in this section.

Table 3.11.4-6. Viewshed analysis for linear features (roads and trails) in Alternative 4

Linear Viewshed Component	Total Miles in Analysis Area	Total Miles within Viewshed	Scenery Impact Discussion
U.S. 60	26.3	18.3	Viewing distance to the facility ranges from approximately 2 to 6 miles. This alternative contains approximately 2 fewer miles of highway within the viewshed than Alternative 2. Impacts are similar to those described under Alternative 2. Specific views from the road are described in the KOP analysis in table 3.11.4-7.
SR 177	4.2	3.6	Viewing distance to the facility ranges from approximately 2 to 6 miles. This alternative contains approximately 1 more mile of highway within the viewshed than Alternative 2. Impacts are similar to those described under Alternative 2. Specific views from the road are described in the KOP analysis in table 3.11.4-7.
Arizona Trail	21.0	16.3	This alternative contains approximately 5.3 more miles of the Arizona Trail within the viewshed than Alternative 2. Impacts are similar to those described under Alternative 2. Specific views from the trail are described in the KOP analysis in table 3.11.4-7.

Viewshed Analysis. The viewshed for Alternative 4 is presented the process memorandum (Newell and Grams 2018). It illustrates the general visibility of the tailings facility across the landscape within the analysis area and shows the high points and location where the facility could be most visible. Viewshed analysis for the linear features in the analysis area is presented in table 3.11.4-6.

KOP Scenery Analysis. We identified sensitive viewpoints (KOPs) in the area around the Silver King tailings facility to analyze impacts on the area's scenery resources (see figure 3.11.1-1). The contrast rating analysis process (described in section 3.11.2.4) for each KOP is presented in table 3.11.4-7. The related contrast rating worksheets and the visual simulations are provided in the process memorandum (Newell and Grams 2018).

MARRCO Corridor

Under Alternative 4, active railcars would transport copper concentrate via the MARRCO corridor instead of pipelines. The two 50-railcar trains would follow the upgraded rail corridor twice a day. Construction impacts on scenery would be similar to those described under Alternative 2. During the operations phase, railcars passing two times per day would present a weak to moderate impact on scenery. Although the trains would be noticeable to viewers along the corridor, the visibility and impact are transitory in nature.

Dark Skies

General impacts on the area's night skies would be the same as described under Alternative 2.

3.11.4.5 Alternative 5 – Peg Leg

The differences in impacts on scenery between Alternatives 2 and 5 are described in the following text.

Tailings Pipeline Corridor

The general scenery impacts described for the tailings pipeline corridor construction, operation, and closure/reclamation would be the same as those described under Alternative 2. However, the pipeline would be in a different location, and there are two options for the pipeline—west

Table 3.11.4-7. Alternative 4 key observation point descriptions and contrast rating analysis

KOP Number	KOP Name	View Description and Contrast Rating Analysis
13	Picketpost Mountain*	The tailings facility would be highly visible from this KOP as presented in the visual simulation package (Newell and Grams 2018). The facility would present prominent changes in the middle ground and background views in form, line, color, and texture. The changes would result in strong contrast and would be highly visible from this KOP.
14	Apache Leap – Tailings*	The tailings facility would be moderately visible from this KOP as presented in the visual simulation package (Newell and Grams 2018). The facility would present changes in background views in line and color and result in moderate contrast because the distance and angle of view of the facility would potentially blend with the background landscape and hill slopes in the foreground of the facility.
15	Arizona Trail – Montana Mountain (Silver King view)*	The tailings facility would be visible from this location and would present a change in contrast ranging from moderate to strong. The foreground hills hide a large portion of the facility. As the facility grows, contrast would increase with the strongest contrast presented at the end of mining operations, but before closure and reclamation is complete.
16	Town of Superior, South Stone Avenue†	The tailings facility would be visible from this location in the middle ground and background. Prior to successful reclamation, the tailings facility would present a strong contrast in the landscape. After reclamation, the contrast would be moderate to weak, depending on the success of revegetation.
17	Town of Superior, Baseball Field†	The tailings facility would be visible from this location in the background view. The facility would obscure a portion of the background ridgeline and present a strong change in form, line, and color. The change in contrast would be most strong and prominent prior to successful concurrent reclamation activities. After reclamation is complete, the facility would be less visible and present a moderate change in contrast. The visual simulation for KOP 17 is presented in figure 3.11.4-3.
18	Arizona Trail – Ridge†	The tailings facility would be visible from this KOP in the middle ground to background landscape, although it would be obscured by some hill slopes in the foreground. Prior to reclamation, the contrast would be strong and would decrease with post-reclamation activities, as described above.
19	U.S. 60 – Near Silver King Wash†	The tailings facility would be visible in the middle ground and background and present strong contrast to viewers traveling the highway. The facility is not obscured by the foreground landscape. The strong contrast would be as described above.
20	SR 177 from Kearny†	The tailings facility would be visible with strong contrast presented in the middle ground to background landscape. The change in form, line, and color would obscure the existing ridgeline. Changes in contrast over time are described above.
21	Picket Post House – (Boyce Thompson Arboretum)†	The tailings facility would be visible with strong contrast presented in the in the background landscape. Changes in contrast related to reclamation and contrast over time are described above.
22	Arizona Trail at Picketpost Trailhead†	The tailings facility would not be visible from this KOP.

* Block model Google Earth visual simulation

† Photograph visual simulation

Figure 3.11.4-3. Visual simulation of Alternative 4 tailings facility from KOP 17 – Town of Superior baseball field

and east. Scenery impacts for both pipeline options are described in the following text.

West Tailings Pipeline Corridor Option—The west pipeline corridor option would be visible from U.S. 60 (at the crossing and parallel segments), NFS OHV roads, Boyce Thompson Arboretum, and Cochran Road (at the crossing).

East Tailings Pipeline Corridor Option—The east pipeline corridor option would be visible from U.S. 60 (at the crossing), NFS OHV roads, Boyce Thompson Arboretum, SR 177, the Arizona Trail (Gila River Canyon Passage 16), and the Florence-Kelvin Highway. Miles of corridor for each visual resource inventory category are given in table 3.11.4-7.

A representative KOP analysis for pipeline impacts is presented under Alternative 6 at KOP 32 – Tailings Pipeline U.S. 60.

Tailings Facility

Although there are differences between the proposed action tailings facility and the Peg Leg tailings facility in terms of design, general impacts on scenery from the facility are similar to those described under Alternative 2. A major difference is that concurrent reclamation would not occur, and reclamation of the tailings embankment face would not begin until mining operations are complete (approximately mine year 46). Without concurrent reclamation, the tailings facility would present strong contrast, with contrast increasing as the facility grows. At mining closure, the facility would be most visible.

Viewshed Analysis. The viewshed for Alternative 5 is presented in the process memorandum (Newell and Grams 2018). It illustrates the general visibility of the tailings facility across the landscape within the analysis area and shows the high points and location where the facility could be most visible. Viewshed analysis for the linear features in the analysis is presented in table 3.11.4-8.

KOP Scenery Analysis. Sensitive viewpoints (KOPs) in the area around the Peg Leg tailings facility were identified to analyze impacts on the area's scenery resources (see figure 3.11.1-1). The contrast rating analysis process (described in section 3.11.2.4) was conducted for each KOP and is presented in table 3.11.4-9. The related contrast rating worksheets and the visual simulations are presented in the process memorandum (Newell and Grams 2018).

Table 3.11.4-8. Viewshed analysis for linear features (roads and trails) in Alternative 5

Linear Viewshed Component	Total Miles in Analysis Area	Total Miles within Viewshed	Scenery Impact Discussion
U.S. 60	27.7	1.5	Although the viewshed model shows that the Peg Leg tailings facility could potentially be viewed from U.S. 60, the facility is too far away to be visible.
SR 177 East Pipeline Option	11.6	1.4	Although the viewshed model shows that the Peg Leg tailings facility could potentially be viewed from SR 177 east pipeline route option, the facility is too far away to be visible.
Arizona Trail	37.2	8.7	This alternative contains approximately 2 fewer miles of the Arizona Trail within the viewshed than Alternative 2. Specific views from the trail are described in the KOP analysis in table 3.11.4-9.

Dark Skies

General impacts on night skies from the mining operations facilities would generally be the same as those described under Alternative 2. However, lighting at the tailings facility would be in a different location. Lighting from the tailings facility would be seen and noticed by nighttime recreationists in the area, Arizona Trail users, and persons

Table 3.11.4-9. Alternative 5 key observation point description and contrast rating analysis

KOP Number	KOP Name	View Description and Contrast Rating Analysis
23	Arizona Trail – Peg Leg North*	The tailings facility would be visible in the background landscape. Because of distance and angle of view, the change in contrast would be moderate. The facility would be noticeable to the casual observer but would not dominate the view.
24	Arizona Trail – Tortilla Mountains*	The tailings facility would be visible in the background landscape view. Because of distance and angle of view, the change in contrast would be moderate. The facility would be noticeable to the casual observer but would not dominate the view.
25	Cochran OHV Parking†	The tailings facility would be visible from this KOP. Although the foreground landscape topography shields the view of the lower portion of the facility, the upper portion would be visible and present a moderate to strong contrast to the existing landscape. The facility would be most visible at the end of mine life and prior to reclamation and revegetation activities. After successful reclamation, the contrast could be reduced to moderate. The visual simulation for KOP 25 is presented in figure 3.11.4-4.
26	Cochran Road OHV Dispersed Site†	The tailings facility would be visible from this KOP. A strong contrast in form, line, and color would dominate the middle ground view. The facility would be most visible at the end of mine life and prior to reclamation and revegetation activities. After successful reclamation, the contrast could be reduced to moderate.
27	Florence-Kelvin Highway – East Side†	The tailings facility would be visible from this KOP in the foreground. A strong contrast would be present in form, line, and color, with strong straight lines dominating the view. The facility would be most visible at the end of mine life and prior to reclamation and revegetation activities. After successful reclamation, the contrast could be reduced to moderate.
28	Florence-Kelvin Highway –South†	The tailings facility would not be visible from this location.

* Block model Google Earth visual simulation
† Photograph visual simulation

Figure 3.11.4-4. Visual simulation of Alternative 5 tailings facility from KOP 25 – Cochran OHV parking

traveling on the Florence-Kelvin Highway. This alternative would also comply with the Pinal Outdoor Lighting Code as described under Alternative 2.

3.11.4.6 Alternative 6 – Skunk Camp

The differences in impacts on scenery between Alternatives 2 and 6 are described in the following text.

Tailings Pipeline Corridor

The general scenery impacts described for the tailings pipeline corridor construction, operation, and closure/reclamation would be the same as those described under Alternative 2. However, the pipeline would be in a different location. There are two options for the pipeline (north and south); scenery impacts are described in the following text.

North Tailings Pipeline Corridor Option—The north pipeline corridor option contains the pipeline corridor and access roads as described in chapter 2, section 2.2.8. The corridor would be visible from U.S. 60 (at the crossing), NFS Road 2466, and Dripping Springs Road. KOP 32 (Tailings Pipeline U.S. 60) illustrates scenery impacts from construction and operation of the tailings pipeline in the vicinity of U.S. 60, the designated Gila-Pinal Scenic Road, and the Oak Flat area. The visual simulation shows the anticipated change in contrast from the existing landscape expected from tailings pipeline operation (Newell and Grams 2018). The tailings pipeline corridor would be visible in the vicinity of the crossing with U.S. 60 at the crossing and on the north and south side of the highway. The visual dominance and contrast would be strong in line, color, and texture. Post-reclamation contrast would be moderate upon successful revegetation and reclamation.

South Tailings Pipeline Corridor Option—The south pipeline corridor option follows the northern portion of the Peg Leg east pipeline corridor option, and impacts in that portion are the same as those described for Alternative 5. It also follows a portion of the Skunk Camp north pipeline corridor option. Additional locations with views of the pipeline corridor not described previously include NFS Road 315.

Transmission Line Corridor

A new power line, approximately 11.5 miles in length, would be constructed between the Silver King substation, north of U.S. 60, and the Skunk Camp tailings facility. Impact on scenery from transmission line construction would generally be the same as described under Alternative 2. This line would be visible from U.S. 60, NFS Road 2466, and Dripping Springs Road.

Tailings Facility

Although there are differences between the proposed action tailings facility and the Skunk Camp tailings facility in terms of design, general impacts on scenery from the facility are similar as those described under Alternative 2. Concurrent reclamation would occur, but the mine year that reclamation would begin is not yet defined. Strong contrast would be visible at the facility until concurrent reclamation is started and successful revegetation of the facility occurs. Although the visual simulations, as described in table 3.11.4-10, illustrate strong to moderate contrast from the tailings facility, in general, impacts on scenery and sensitive viewers in the Skunk Camp area are less than for the other alternatives. This is because there are limited areas where the facility would be visible and fewer sensitive viewers in the vicinity.

Viewshed Analysis. The viewshed for Alternative 6 is presented in the process memorandum (Newell and Grams 2018). It illustrates the general visibility of the tailings facility across the landscape within the analysis area and shows the high points and location where the facility could be most visible. Linear facilities (U.S. 60, SR 177, and the Arizona Trail) are not visible within the viewshed model for the Skunk Camp tailings facility.

KOP Scenery Analysis. Sensitive viewpoints (KOPs) in the area around the Skunk Camp tailings facility were identified to analyze impacts on the area's scenery resources (see figure 3.11.1-1). The contrast rating analysis process (described in section 3.11.2.4) was conducted for each KOP and is presented in table 3.11.4-10. The related contrast rating

Table 3.11.4-10. Alternative 6 key observation point description and contrast rating analysis

KOP Number	KOP Name	View Description and Contrast Rating Analysis
29	Dripping Springs Road*	The tailings facility would be highly visible from this KOP and the contrast in form, line, color, and texture would be strong. The facility would dominate the foreground view and obscure the mountains and ridgeline views of the background. Because of proximity and angle of view, the contrast would remain strong and dominate the view after closure and reclamation. The visual simulation for KOP 29 is presented in figure 3.11.4-5.
30	Pinal Peak†	The tailings facility would be visible from this KOP in the background valley below. The contrast would be strong in form, line, and color until reclamation is complete. Post-reclamation contrast would be moderate upon successful revegetation and reclamation of the facility.
31	San Carlos†	The tailings facility would be visible from this KOP in the background valley below. The contrast would be strong in form, line, and color until reclamation is complete. Post-reclamation contrast would be moderate upon successful revegetation and reclamation of the facility.
32	Tailings Pipeline U.S. 60*	The tailings pipeline corridor would be visible in the vicinity of the crossing with U.S. 60 at the crossing and on the north and south side of the highway. It would also be intermittently visible to persons travelling east on U.S. 60. The visual dominance and contrast would be strong in line, color, and texture. Post-reclamation contrast would be moderate upon successful revegetation and reclamation.

* Photograph visual simulation

† Block model Google Earth visual simulation

worksheets and the visual simulations are presented in the process memorandum (Newell and Grams 2018).

Dark Skies

General impacts on night skies from the mining operations facilities would generally be the same as described under Alternative 2. However, lighting at the tailings facility would be in a different location. The facility would be lit and visible from the surrounding area. There would be few observers of the night sky in the area because of the remote location of the facility. This alternative would also comply with the Pinal Outdoor Lighting Code as described under Alternative 2. The Skunk Camp tailings facility would be located in Gila County and the lighting plan for this component would be designed in compliance with the Gila County Outdoor Light Control Ordinance.

3.11.4.7 Forest Service and BLM Scenery Management Designations

Table 3.11.4-11 presents the Tonto National Forest and the BLM scenery management designation acreages by project area alternative component. The acreages represent areas where the proposed project components cross Federal lands. Total acreages vary, depending upon the amount of private or State lands included in the project area alternatives.

The majority of project area alternatives on NFS lands are designated Retention, Partial Retention, and Modification. In general terms, Retention and Partial Retention do not allow for the proposed project activities as a whole. Retention requires that activities be “not visually evident.” Partial Retention requires that activities be “visually subordinate” to the characteristic landscape. The Modification designation allows for activities to visually dominate the original character of the landscape, but vegetation and landform should mimic the natural landscape. With adequate mitigation, including revegetation, the project as proposed could meet the Modification designation. Under Alternative 4, 1,847 acres of the project area are designated Maximum

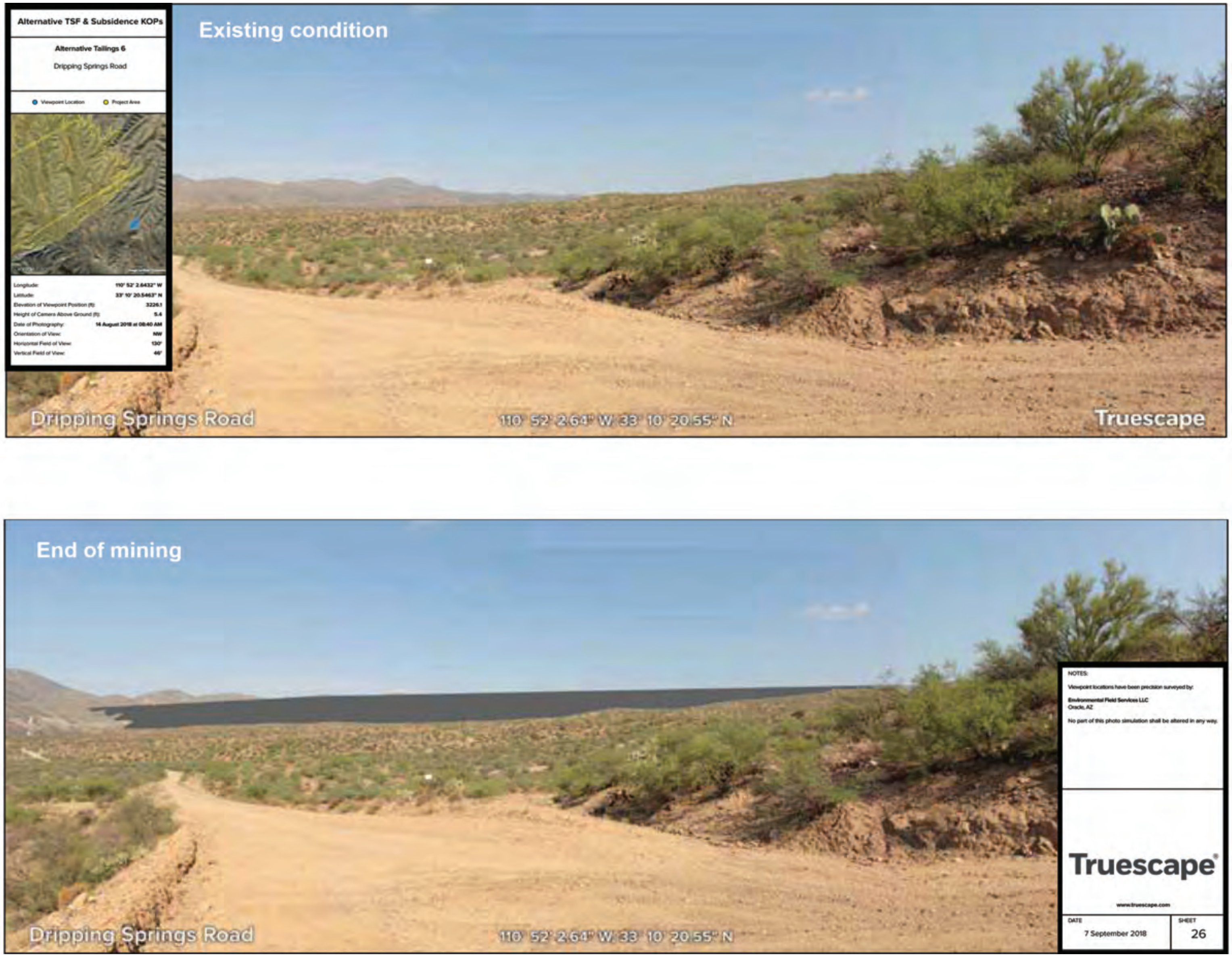


Figure 3.11.4-5. Visual simulation of Alternative 6 tailings facility from KOP 29 – Dripping Springs Road

Table 3.11.4-11. Project area alternative scenery management designation acreage

	Alternatives 2 and 3	Alternative 4	Alternative 5 (East)	Alternative 5 (West)	Alternative 6 (North)	Alternative 6 (South)
VQO						
Preservation	0	0	0	0	0	0
Retention	393	371	691	530	676	771
Partial Retention	5,184	4,663	1,905	1,824	2,043	2,225
Modification	1,705	1,178	222	371	592	530
Maximum Modification	0	1,847	0	0	0	0
VRM						
Class III	0	0	7,086	7,558	0	0
Class I, II, IV	0	0	0	0	0	0
Total Acreage	**7,282**	**8,059**	**9,904**	**10,283**	**3,311**	**3,526**

Modification. With mitigation, this designation would allow for the proposed project activities.

Portions of NFS lands that would not meet the VQO designations include the following:

- Retention Acres—Alternatives 2 and 3 (393), Alternative 4 (371), Alternative 5 East (691), Alternative 5 West (530), Alternative 6 North (676), Alternative 6 South (771)
- Partial Retention Acres—Alternatives 2 and 3 (5,184), Alternative 4 (4,663), Alternative 5 East (1,905), Alternative 5 West (1,824), Alternative 6 North (2,043), Alternative 6 South (2,225)

Alternatives 2 and 3 have the least acres designated Retention, with Alternative 6 (south option) having the most. Alternative 5 (west option) has the least acres designated Partial Retention with Alternatives 2 and 3 having the most.

Alternative 5 is the only alternative on BLM lands, and it intersects with BLM VRM Class III designation (Alternative 5 [east option] 7,086 acres, and Alternative 5 [west option] 7,558 acres). The designation does not preclude mining activities but does require that activities not dominate the view of the casual observer. The level of change to the characteristic landscape from Alternative 5 would likely be deemed too great to meet the requirements of the Class III designation because the tailings facility would dominate the view from several viewpoints.

3.11.4.8 Cumulative Effects

The Tonto National Forest identified the following list of reasonably foreseeable future actions as likely to occur in conjunction with development of the Resolution Copper Mine. These RFFAs may contribute to cumulative changes in scenic resources in the assessment area, including in the vicinity of the proposed Resolution Copper Mine and its project alternative components, as well as in the visual landscape viewed from distant locations, where the viewshed could include proposed project components along with RFFA project

components, resulting in a cumulative scenic resources impact. As noted in section 3.1, past and present actions are assessed as part of the affected environment; this section analyzes the effects of any RFFAs, to be considered cumulatively along with the affected environment and Resolution Copper Project effects.

- *Ripsey Wash Tailings Project.* Mining company ASARCO is planning to construct a new tailings storage facility to support its Ray Mine operations. As approved, the proposed tailings storage facility project would occupy 2,627 acres of private lands and 9 acres of BLM lands and be situated within the Ripsey Wash watershed just south of the Gila River approximately 5 miles west-northwest of Kearny, Arizona, and would contain up to 750 million tons of material (tailings and embankment material). The tailings facility would include two starter dams, new pipelines to transport tailings and reclaimed water, a pumping booster station, a containment pond, a pipeline bridge across the Gila River, and other supporting infrastructure. ASARCO estimates a construction period of 3 years and approximately 50 years of expansion of the footprint of the tailings storage facility as slurry tailings are added to the facility, followed by a 7- to 10-year period for reclamation and final closure. A segment of the Arizona Trail would be relocated east of the tailings storage facility. If the Alternative 5 – Peg Leg tailings storage facility location is selected as the agency-preferred alternative, then the proximity of Ripsey Wash tailings storage facility and the Peg Leg tailings storage facility would have cumulative effects on scenic resources. The Ripsey Wash tailings storage facility would be located within the same viewshed as the Peg Leg facility. Both facilities would cumulatively affect the areas scenic quality. The Ripsey Wash tailings storage facility would result in large-scale, permanent changes in the landscape that would create strong visual contrasts and cause major and highly noticeable changes to the area's existing character. The Ripsey Wash tailings storage facility at full build-out would be visible from portions of the Florence-Kelvin Highway, SR 177, the Arizona Trail, and various OHV routes in the vicinity. The facility would also be visible in the background view from the White Canyon Wilderness, although views of the Ripsey Wash tailings storage facility from the wilderness would be from relatively inaccessible areas with rugged and steep terrain that are expected to have limited public visitation.
- *Ray Land Exchange and Proposed Plan Amendment.* ASARCO is seeking to complete a land exchange with the BLM by which the mining company would gain title to approximately 10,976 acres of public lands and federally owned mineral estate located near ASARCO's Ray Mine in exchange for transferring to the BLM approximately 7,304 acres of private lands, primarily in northwestern Arizona. It is known that at some point ASARCO wishes to develop an open-pit copper mining operation in the "Copper Butte" area west of the Ray Mine; however, no details are currently available as to specific mine development plans and how these would affect scenic resources in this popular recreation area and from surrounding viewpoints.
- *Silver Bar Mining Regional Landfill and Cottonwood Canyon Road*. AK Mineral Mountain, LLC, NL Mineral Mountain, LLC, POG Mineral Mountain, LLC, SMT Mineral Mountain, LLC, and Welch Mineral Mountain, LLC proposed to build a municipal solid waste landfill on private property surrounded by BLM land in an area known as the Middle Gila Canyons area. There is no way to access the proposed landfill without crossing BLM land. The owners/developers and Pinal County have applied for a BLM right-of-way grant and Temporary Use Permit for two temporary construction sites to obtain legal access to the private property and authorization of the needed roadway improvements. The proposed action includes improving a portion of the existing Cottonwood Canyon Road and a portion of the existing Sandman Road in order to accommodate two-way heavy truck traffic to and from the proposed landfill. The access road on BLM-administered land would be widened to 44 feet as needed. The overall life of the proposed landfill is 50 years. The slight widening of the road to

accommodate drainage would not have an impact on the overall characteristics of the landscape; however, the proposed landfill would be visible from SR 79, U.S. 60, and Cottonwood Canyon Road. Visual impacts would be greatest on Cottonwood Canyon Road.

- *ADOT Vegetation Treatment.* ADOT plans to conduct annual treatments using EPA-approved herbicides to contain, control, or eradicate noxious, invasive, and native plant species that pose safety hazards or threaten native plant communities on road easements and NFS lands up to 200 feet beyond road easement on the Tonto National Forest. It can be reasonably assumed that ADOT will continue to conduct vegetation treatments along U.S. 60 on the Tonto National Forest during the expected life of the Resolution Copper Mine (50–55 years) for safety reasons. The vegetation treatment could measurably impact cumulative scenic resources.
- *Tonto National Forest Travel Management Plan.* The Tonto National Forest is currently in the process of developing a Supplemental EIS to address certain court-identified deficiencies in its 2016 Final Travel Management Rule EIS. This document and its implementing decisions are expected within the next 2 years. This document will have substantial impacts on current recreational uses of NFS lands and transportation routes, which in turn would have some impact on disturbance of scenery resources from new road construction or decommissioning of other roads.

Other future projects not yet planned, such as large-scale mining activity, pipeline projects, power transmission line projects, and other utility infrastructure development, are expected to occur in this area of south-central Arizona during the foreseeable future life of the Resolution Copper Mine (50–55 years). These types of unplanned projects, as well as the specific RFFAs listed here, would cumulatively contribute to future changes in scenic resources in the region.

3.11.4.9 Mitigation Effectiveness

Mitigation Measures Applicable to Scenic Resources

Minimize visual impacts from transmission lines (FS-03). Resolution Copper would use best management practices or other guidelines (when on NFS lands) that would minimize visual impacts from transmission lines. Measures could include using non-specular transmission lines, transformers, and towers; avoiding use of monopole transmission structures; avoiding “skylining” of transmission and communication towers and other structures (i.e., consider topography when siting transmission structures to avoid “skylining” of structures on high ridges in the landscape); and in areas of the highest visual sensitivity with difficult access, use of air transport capability to mobilize equipment and materials for clearing, grading, and erecting transmission towers. These measures would reduce and minimize the scenery impacts and project contrast of mining operations in the surrounding landscape and impacts upon sensitive viewers. The power line corridors occur mainly on Forest Service–managed lands, and the mitigation measures can be required within those areas, regardless of alternative.

Mitigation Effectiveness and Impacts

Applying mitigation to transmission lines would be effective in reducing impacts on scenery resources and sensitive viewers on NFS lands through reducing impacts from increased contrast from form and line introduced into the landscape. In particular, avoiding “skylining” of structures would reduce visual dominance relative to the existing landscape through increased screening of views and reduce impacts on sensitive viewers. Impacts related to this mitigation would be related to air transport of equipment and materials. This would cause noise and scenery impacts on national forest visitors in the vicinity of the transmission line. However, these impacts would only occur during construction and would be temporary.

Unavoidable Adverse Impacts

The subsidence area and residual tailings storage facility would constitute a permanent adverse impact that cannot be avoided or completely mitigated. While night brightness from mine facility lighting would be mitigated to a large degree, residual impacts would remain that are not avoidable and cannot be completely mitigated.

3.11.4.10 Other Required Disclosures

Short-Term Use and Long-Term Productivity

Impacts on visual resources would be both short and long term. While impacts associated with processing plant buildings and structures such as utility lines and fences would cease when they are removed at closure, the subsidence area and tailings storage facility would permanently alter the scenic landscape and affect the scenic quality of the area in perpetuity. Impacts on dark skies from night lighting would cease after mine closure and reclamation.

Irreversible and Irretrievable Commitment of Resources

For all action alternatives, there would be an irretrievable loss of scenic quality from increased activity and traffic during the construction and operation phases of the mine. The size and extent of the tailings facilities would create losses of scenic quality until rock weathering and slope revegetation have reduced color, form, line, and texture contrasts to a degree that they blend in with the surrounding landscape; revegetation would occur relatively soon after closure, but weathering would take such a long time scale as to be considered permanent. Due to the geological time frame necessary for these processes to occur, the loss of scenic quality associated with the tailings facilities would effectively be irreversible.

For each action alternative, the visual contrasts that would result from the introduction of facilities associated with the project would be an irretrievable loss of the undeveloped, semiprimitive setting until the project is closed and full reclamation is complete. Under all of the action alternatives, existing views would be irreversibly lost behind the tailings storage facility because of the height and extent of the piles.

There would be an irretrievable, regional, long-term loss of night-sky viewing during project construction and operations because night-sky brightening, light pollution, and sky glow caused by mine lighting would diminish nighttime viewing conditions in the direction of the mine. Impacts on dark skies due to night lighting would cease after mine closure and reclamation. Regional dark skies would continue to brighten due to other development factors in the region throughout the mine life. Therefore, it is unlikely that a return to current dark sky conditions would occur after mine closure.

Overview

Applicable laws that oversee cultural resources management in the United States include the National Historic Preservation Act, Archaeological Resources Protection Act, and numerous other laws and regulations at various levels of government. Despite the host of laws in place to mandate and oversee the detailed cultural resources surveys undertaken on behalf of Resolution Copper, it is likely that some portion of currently buried or otherwise undetected prehistoric (Native American only) and historic (Native American and Euro-American) artifacts and resources could be lost to mine-related construction and operation. This is especially true in areas such as Oak Flat, the Queen Creek watershed, and the Superior area, which have long histories of human habitation. Even those sites and artifacts that researchers have recorded and archived would be irrevocably altered.

3.12 Cultural Resources

3.12.1 Introduction

Cultural resources consist of the physical aspects of the activities of past or present cultures, including archaeological sites, historic buildings and structures, trails, roads, infrastructure, traditional cultural properties, and other places of traditional, cultural, or religious importance. Cultural resources can be human-made or natural features and are, for the most part, unique, finite, and nonrenewable. Cultural resources are often discussed in terms of historic properties under the National Historic Preservation Act (NHPA); however, the term "historic properties" has a very specific definition that may omit other resources that are critical to NEPA analysis but do not qualify as historic properties. This analysis is designed to capture potential impacts on cultural resources within the project area; however, it focuses on the potential impacts on historic properties (i.e., cultural resources that are listed in or have been determined eligible for listing in the National Register of Historic Places [NRHP]) and cultural resources that have not been evaluated for their NRHP status. The numbers and types of historic properties and those resources that may be historic properties represent the best possible information about cultural resources that can be verified and quantified.

3.12.2 Analysis Methodology, Assumptions, and Uncertain and Unknown Information

3.12.2.1 Analysis Area

There are three distinct analysis areas for this discussion: the direct impacts analysis area, the indirect impacts analysis area, and the atmospheric impacts analysis area. The direct impacts analysis area for each alternative consists of the complete footprint of all project elements, including the lands leaving Federal management under the land exchange. The analysis areas for cultural resources for the GPO correspond to the Section 106 of the NHPA direct and indirect areas of potential effects, defined by 36 CFR 800.16(d) as "the geographic area or areas within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties."

For the direct analysis area, the analysis assumes that all areas within those boundaries or fence lines would be disturbed. Indirect impacts include visual impacts from project elements. The direct analysis area for the proposed project is defined by several factors: the acreage of ground disturbance expected for each mine component described in the GPO and the acreage of land leaving Federal stewardship as a result of the land exchange. The direct analysis area for the proposed action (GPO and land exchange) is approximately 40,988 acres and consists of the following, which includes access roads and other linear infrastructure:

- East Plant Site and subsidence area, including the reroute of Magma Mine Road

(1,539 acres that is partially within the Oak Flat Federal Parcel and includes private, NFS, and ASLD lands);

- 2,422-acre Oak Flat Federal Parcel of NFS land to be exchanged with Resolution Copper;
- 940-acre West Plant Site;
- 6.96-mile Silver King to Oak Flat transmission line;
- 169-acre MARRCO railroad corridor and adjacent project components;
- 553-acre filter plant and loadout facility; and
- Alternatives 2–6 tailings storage facilities and tailings corridors: tailings storage facility and tailings corridor for Alternatives 2 and 3; and Alternative 4 – Silver King, Alternative 5 – Peg Leg, and Alternative 6 – Skunk Camp, which have different locations and overall footprints from the GPO tailings storage facility and tailings corridor.

The indirect impacts analysis area consists of a 2-mile buffer around all project and alternative components. The 2-mile buffer is designed to account for impacts on resources not directly tied to ground disturbance and outside the direct analysis area. Potential indirect impacts include, but are not limited to, inadvertent damage, vandalism, unsanctioned collecting, and impacts caused by vibration from mine construction and operations.

The atmospheric impacts analysis area (including visual and auditory impacts) consists of a 6-mile buffer around all project and alternative components, which has been split into three distance zones: less than 1 mile, 1 to 3 miles, and greater than 3 miles from the project area. This distance is consistent with the indirect analysis area for visual impacts (see section 3.11), which is based on BLM visual guidance and Forest Service guidance for assessing visual effects. The atmospheric impacts analysis area encompasses approximately 729,674 acres for all project components under all alternatives. The analysis area for cultural resources is shown in figure 3.12.2-1.

Various permitted archaeological contractors over the past 15 years collected data through Class I records searches (records check at local, State, and Federal levels) and Class III pedestrian surveys (field crews systematically walk the analysis area and record resources). As of June 2019, crews had surveyed the direct analysis areas for cultural resources, except for portions of Alternative 6 – Skunk Camp and the pipeline routes not within previously surveyed areas. In addition, although previously surveyed, the East Plant Site underwent additional sample surveys in 2018. As many of the data that were available were used in this analysis. Please note that some survey results are preliminary and may change after the DEIS is published.

3.12.2.2 Impact Indicators

Direct impact on a historic property would consist of damage, loss, or disturbance caused by ground disturbance that would alter the characteristic(s) that make the property eligible for listing in the NRHP. Indirect impacts would consist primarily of visual impacts from alterations to setting, feeling, or association of a resource where setting is a significant component of its NRHP eligibility; however, other indirect impacts such as auditory impacts or inadvertent disturbance are also assessed.

Impact indicators for this analysis include the following:

- Loss, damage, or disturbance to resources listed in State or Federal registers;
- Loss, damage, or disturbance to resources that are eligible or may be eligible for State or Federal registers;
- Loss, damage, or disturbance to traditional cultural properties (TCPs); and
- Alterations to setting, feeling, or association for a historic property listed in or eligible to be listed in the National or State register under Criteria A, B, and/or C.

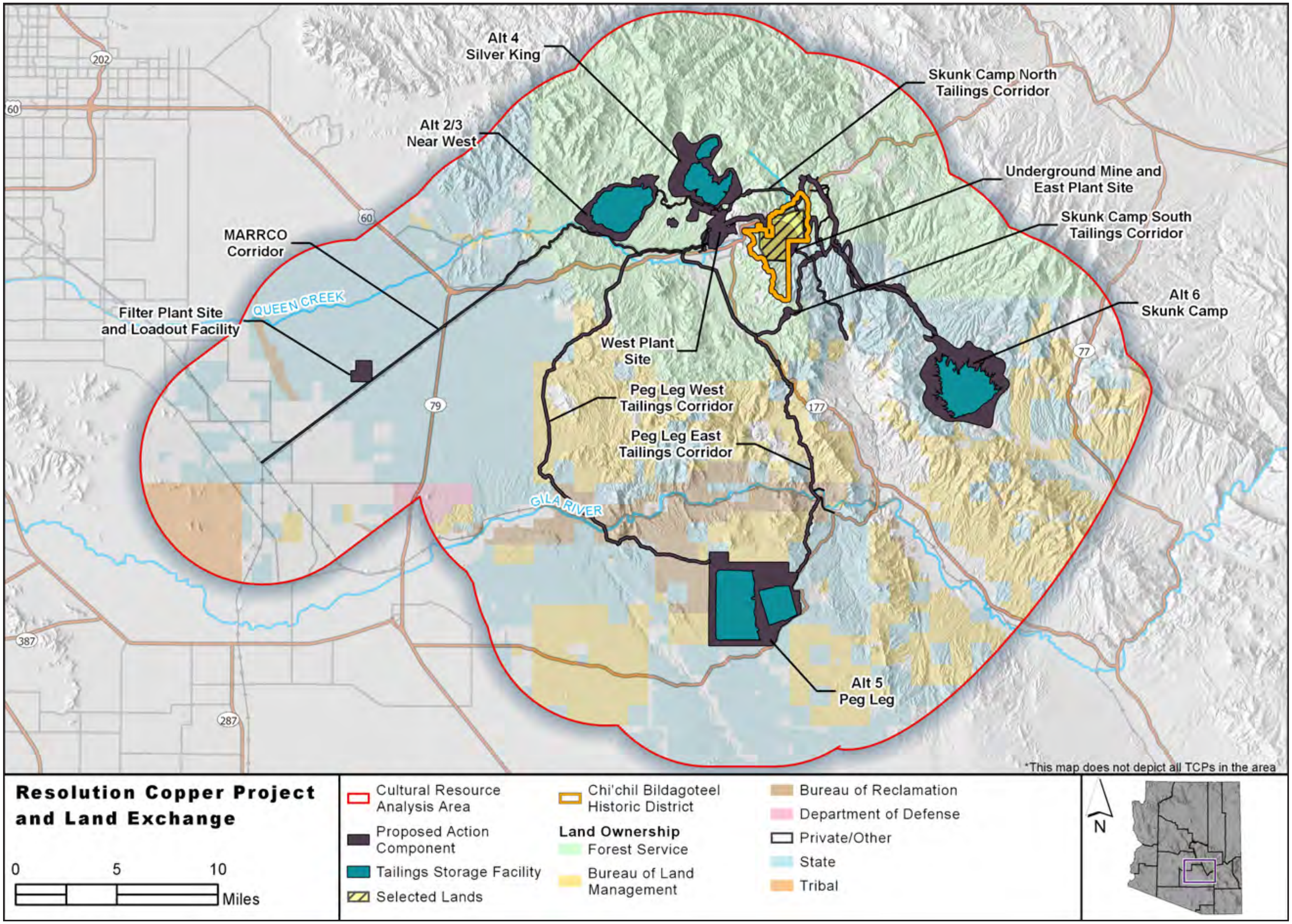


Figure 3.12.2-1. Direct and indirect analysis areas for cultural resources

Adverse impacts on historic properties would be avoided, minimized, or mitigated through the NHPA Section 106 process.

3.12.3 Affected Environment

3.12.3.1 Relevant Laws, Regulations, Policies, and Plans

The primary Federal, State, and agency regulations, policies, and guidelines used to analyze potential impacts on cultural resources in the project analysis area are shown in the accompanying text box.

A complete listing and brief description of the legal authorities and agency guidance used in this cultural resources impacts analysis may be reviewed in Newell (2018a).

Regulations, Policies, and Guidelines Used in the Cultural Resources Effects Analysis

- National Historic Preservation Act (NHPA) of 1966 (54 U.S.C. 300101 et seq.)
- Archaeological Resources Protection Act (ARPA) of 1979 (16 U.S.C. 470aa–470mm)
- American Indian Religious Freedom Act (AIRFA) of 1978 (42 U.S.C. 1996)
- Native American Graves Protection and Repatriation Act (NAGPRA) of 1990 (25 U.S.C. 3001–3013)
- Executive Order 13007 (May 24, 1996), "Indian Sacred Sites"
- Executive Order 13175 (November 6, 2000), "Consultation and Coordination with Indian Tribal Governments"
- Arizona Antiquities Act of 1960 (ARS 41-841 through 41-844)
- State Historic Preservation Act of 1982 (ARS 41-861 through 41-865)
- Tonto National Forest Land and Resource Management Plan

3.12.3.2 Existing Conditions and Ongoing Trends

Human occupation of east-central Arizona spans from the Paleoindian period to today, with the primary occupation in the project area vicinity from the Formative era to the Late Historic period. Detailed summaries of the cultural history of the area can be found in many reference reports (see, for example, Lindeman and Whitney (2005) and Buckles (2009)). The following section is a brief overview to provide context for discussing potential impacts from the proposed project.

Cultural History

PALEOINDIAN PERIOD

The earliest human occupation of the Southwest and Arizona is known as the Paleoindian tradition and associated with hunters living in the end of the Pleistocene glaciations (9500–8500 B.C.). The Paleoindian tradition is defined by a series of large projectile (spear) points that are often found in association with late Pleistocene megafauna such as the mammoth and bison. Clovis, the earliest Paleoindian complex, is characterized by distinctive lanceolate points. Following Clovis is the

Folsom complex (8900–8200 B.C.), identified by a smaller fluted point most commonly found in association with bison remains. Most Folsom finds in Arizona come from the Colorado Plateau. The Folsom tradition is followed by a series of other poorly dated and sometimes overlapping complexes, including the Plainview, Agate Basin, and Cody complexes. Most of the point types (Plainview, Agate Basin, Eden, and Scottsbluff) associated with these complexes have also been found on the Colorado Plateau.

ARCHAIC PERIOD

The Archaic period spans roughly from 8000 B.C. to A.D. 300 in the Southwest, beginning around the time of the Pleistocene-Holocene transition and the extinction of the Pleistocene big game. Archaeologists divide the Archaic period based on projectile point styles: Early Archaic (8000–5000 B.C.), Middle Archaic (5000–ca. 2000 B.C.), and Late Archaic–Early Agricultural (ca. 2000 B.C. up to A.D. 250). Archaic groups were hunter-gatherers specializing in exploiting small-game and plant resources. They traveled in a seasonal pattern exploiting specific resources in their territory as those resources became available or ripe. Archaic remains are represented by campsites or resource procurement and/or processing sites.

The Late Archaic is also referred to as the Early Agricultural period. The introduction of agriculture transformed cultures in the Southwest, but there is still debate about when and how this transformation occurred. Maize was introduced from Mexico before A.D. 1, and possibly as early as 2100 B.C. The Late Archaic–Early Agricultural period sees the beginning of village life, with agricultural communities appearing on floodplains. However, while maize and other crop cultivation became increasingly important over time, wild resources continued to play a large role in Late Archaic–Early Agricultural subsistence patterns. The end of the Late Archaic–Early Agricultural period is signaled by the adoption of ceramic vessels.

FORMATIVE PERIOD

Hohokam

The Formative era begins with the appearance of pottery in the archaeological record. In central Arizona, the best-documented and most common archaeological remains are attributed to the Hohokam culture. The Hohokam lifeway was characterized by a mixed subsistence pattern of wild resources and agricultural products, pottery (both plain and decorated red-on-buff wares), pit houses, and canal irrigation. Later Hohokam participated in large exchange networks and constructed ball courts and platform mounds. However, by the Late Formative, the Hohokam were in decline due to overpopulation, loss of agricultural production, and droughts.

Salado

During the Late Formative, Salado ceramics began to appear in central Arizona. The Salado culture was centered on the Tonto Basin in the Late Formative, and, while heavily influenced by Hohokam culture, developed with a unique set of traits and patterns. Salado culture is characterized by polychrome pottery and aboveground masonry structures within compounds. Evidence of trade networks can be seen in the spread of polychrome pottery in southern Arizona. At the end of the Formative, a reorganization of Salado sites can be seen, with many villages abandoned in favor of a smaller number of larger settlements, possibly due to conflicts. The Salado went into decline likely due to environmental factors and population pressure, and by the end of the Formative period most Salado sites were abandoned.

PROTOHISTORIC AND HISTORIC NATIVE AMERICAN

The project area is within the traditional territories of the Western Apache, the Yavapai, and the Akimel O’odham or Upper Pima. The histories of the Western Apache—a group that includes ancestors of the White Mountain, San Carlos, Cibecue, and Tonto Apache—tell of migrations into Arizona where they encountered the last inhabitants of villages along the Gila and San Pedro Rivers. The Western Apache

practiced a mixed subsistence strategy of farming in the summer in the north, and hunting and gathering in the winter in the south. In the 1870s, the Apache were forced onto reservations, which curtailed much of their seasonal round. However, not all Apache stayed on the reservations, and some continued to use the vicinity of the project area into the twentieth century. Like the Western Apache, the Yavapai practiced a mixed subsistence strategy with an emphasis on hunting and gathering. Yavapais had little contact with Euro-Americans until the 1860s, and also like the Apache, after silver was discovered in Arizona, they were forced onto reservations in the 1870s. The Akimel O'odham were primarily farmers who also practiced hunting and gathering of wild resources. They and other O'odham groups are the likely descendants of the Hohokam, and like the Hohokam, lived along the Gila River to the west of the project area. The year-round source of water allowed them to settle large villages and cultivate more crops with irrigation agriculture than some of the other O'odham groups in harsher areas of the desert while still gathering resources from the surrounding areas.

HISTORIC EURO-AMERICAN

Spanish, Mexican, and Euro-American settlers began to arrive in appreciable numbers in the eighteenth century. The ensuing period of historical exploitation was marked by mining, ranching, and homesteading interests. These historical pursuits included the construction of new canals, as well as the reuse of prehistoric ones. With the acquisition of southern Arizona from Mexico in 1853, the United States became the most current heir to the American Southwest. The discovery of gold in California, the 1862 Homestead Act, and development of gold and silver mines in western and central Arizona heralded the arrival of a large number of Euro-American settlers by the mid-1870s. During the late 1800s, cattle and mining industries were established. Technological innovations (such as pumps) and improvements in irrigation methods led to intensified agricultural development and population growth into the twentieth century.

Inventories of the Direct Impacts Analysis Area

To date, 33 cultural resource surveys, inventories, or monitoring projects have been completed within the direct analysis area.[69] Fourteen surveys have been conducted in the selected lands and/or East Plant Site (Benz 2006; Buckles 2008; Buckles and Granger 2009; Chamorro 2014a, 2015; Deaver 2010, 2017; Dolan and Deaver 2007; Lindeman 2003; Lindeman and Whitney 2005; Prasciunas and Chamorro 2012; WestLand Resources Inc. 2009). Five surveys or inventories were conducted within the West Plant Site (Chamorro 2015; Deaver 2012; Steely 2011). Five surveys or monitoring projects were conducted within the tailings storage facility and corridor (Chamorro 2014b; Chamorro et al. 2016; Hooper 2014; Hooper and Tinseth 2015). Seven surveys were conducted within the MARRCO corridor and the filter plant and loadout facility (Buckles 2007; Buckles and Jerla 2008; Buckles et al. 2012; Cook 2007a, 2007b; King and Buckles 2015; Ryden et al. 2004). Surveys of the Silver King and Peg Leg sites have been completed or partially completed (Chamorro, Brown, et al. 2019; Chamorro, Tinseth, et al. 2019). Please note that these reports are still in draft form; any changes in the final report will be reflected in the FEIS. The surveys of Skunk Camp and Peg Leg pipeline routes are still underway. Reports are not available, but preliminary data for completed areas are available and have been used in the DEIS. These surveys and inventories have resulted in the recordation of 721 archaeological sites and three historical buildings or structures within the direct analysis area.

69. Two of the surveys listed cover more than one mine facility. Readers should note that while all references and citations for the EIS are made available via the EIS website, reports containing locational information of cultural resources are considered to be sensitive; therefore, only redacted versions may be made available, subject to the decision of the Forest Supervisor.

Incomplete or Missing Information

Survey of Alternative 5 – Peg Leg pipeline route options and some small areas of other project components that have moved as a result of design changes will occur in 2019. The results will be updated in the FEIS.

Inventory of the Indirect Impacts Analysis Area

For the indirect impacts analysis area, SWCA Environmental Consultants (SWCA) conducted a Class I records search of the area. The cultural resources team searched AZSITE—the online cultural resources database that contains records from the SHPO, BLM, and the ASLD—as well as records housed at the Tonto National Forest Phoenix Office and the BLM Tucson and Lower Sonoran Field Offices, for all recorded archaeological sites within 2 miles of the direct analysis area. The NRHP database was also searched for historic properties listed within 2 miles of the direct analysis area.

Inventory of the Atmospheric Impacts Analysis Area

For the atmospheric impacts analysis area, SWCA conducted a Class I records search of the area. The cultural resources team searched AZSITE, the Tonto National Forest Phoenix Office records, and the BLM Tucson and Lower Sonoran Field Offices records. Personnel also searched the NRHP for resources listed in or eligible for listing in the NRHP (historic properties) under Criteria A, B, and/or C. Historic properties eligible for the NRHP under Criteria A, B, and/or C are more likely to be sensitive to impacts on setting than properties determined to be eligible under Criterion D.

Direct Analysis Area

ARCHAEOLOGICAL SITES

Within the direct impacts analysis area, 721 archaeological sites have been recorded. This total includes preliminary data from the Silver King, Peg Leg, and Skunk Camp alternatives. Of the 721 sites, 523 are recommended or determined eligible for the NRHP, 118 are recommended or determined not eligible for the NRHP, 78 are undetermined, and two are exempt from Section 106 compliance.

The archaeological sites range in age from the Archaic to Historic periods and several sites have two or more temporal components. Cultural site components are attributed to Archaic peoples (19), Hohokam (81), Hohokam-Salado (73), Salado (330), Apache-Yavapai (25), Native American (116), Euro-American (189), and unknown (4). Archaeological sites found in the analysis area represent short- and long-term habitations, agricultural sites, resource procurement and processing sites, campsites, a historic-age campground, communication sites, ranching sites, mining sites, soil conservation, utilities, transportation (roads and trails), recreation activities, water management, and waste management.

TRADITIONAL CULTURAL PROPERTY

One NRHP-listed TCP is located within the direct analysis area: the *Chí'chil Biłdagoteel* Historic District. The *Chí'chil Biłdagoteel* Historic District was listed on the NRHP in 2016 as an Apache TCP and its boundaries contain 38 archaeological sites that contribute to the overall eligibility of the district, in addition to sacred places, springs, and other significant locations. See Section 3.14, Tribal Values and Concerns, for a more detailed discussion of the resource. Of the 38 archaeological sites within the TCP, six are found within the direct impacts analysis area.

HISTORIC BUILDINGS AND STRUCTURES

Twenty-one historic buildings or structures have been recorded within the direct analysis area. Seventeen of the historic buildings or structures are associated with the Magma Mine; however, all but three have been demolished as part of a reclamation plan. No formal recommendation or determination of eligibility has been made for the Magma Mine resources. The remaining four resources are in-use historic-era linear resources (roads and utility lines). All four are found in the Peg Leg alternative and are recommended not eligible for the NRHP.

Indirect Analysis Area

The Class I records search of the indirect analysis area resulted in 568 cultural resources. Of the 568, eight are listed in the NRHP, 257 are eligible for listing in the NRHP, 245 are unevaluated, and 58 are not eligible. The majority of the eligible resources are Prehistoric and Historic archaeological sites eligible under Criterion D for their information potential. The eight listed resources are the Gabel House, The Eleven Arches, the Erskine P. Caldwell House, the Magma Hotel, the Boyce Thompson Arboretum, the Butte-Cochran Charcoal Ovens, the Queen Creek Bridge, and the Devil's Canyon Bridge.

Atmospheric Analysis Area

The Class I records search of the atmospheric analysis area for historic properties listed in or eligible for listing in the NRHP under Criterion A, B, or C resulted in 13 historic buildings, structures, or districts listed in the NRHP and 37 archaeological sites eligible for listing in the NRHP. The historic buildings include several houses and a hotel. Historic structures include five bridges, charcoal ovens, and the Boyce Thompson Arboretum. One district is also present within the indirect analysis area: the *Chí'chil Biłdagoteel* Historic District. Archaeological sites include Civilian Conservation Corps features, mining sites, roads and highways, railroads, and transmission lines, as well as prehistoric artifact scatters and petroglyph sites.

3.12.4 Environmental Consequences of Implementation of the Proposed Mine Plan and Alternatives

3.12.4.1 Alternative 1 – No Action

Direct Impacts

Under the no action alternative, the Forest Service would not approve the GPO, and current management plans would be in place. Resolution Copper would continue current activities on private property. As described in section 2.2.2, the no action alternative analysis analyzes the impacts of (1) the Forest Service's not approving the GPO, and (2) the land exchange's not occurring.

If the GPO is not approved, the proposed Resolution Copper Project would not occur, and no adverse direct impacts on cultural resources would be anticipated. If the land exchange does not occur, the selected lands would remain under Federal management, and no direct adverse impacts on cultural resources would be anticipated. Current management of historic properties and other cultural resources would continue as it is today.

Indirect Impacts

If the GPO is not approved, the mine would not occur, and no adverse indirect impacts on cultural resources would be anticipated. If the land exchange does not occur, the selected lands would remain under Federal management, and no indirect adverse impacts on cultural resources would be anticipated.

Atmospheric Impacts

If the GPO is not approved, then none of the proposed mining facilities would be constructed, so no adverse indirect impacts on cultural resources would be anticipated from mining facilities. If the land exchange does not occur, no adverse indirect impacts on cultural resources would be anticipated.

3.12.4.2 Impacts Common to All Action Alternatives

Effects of the Land Exchange

The land exchange would have effects on cultural resources.

The Oak Flat Federal Parcel would leave Forest Service jurisdiction. The role of the Tonto National Forest under its primary authorities in the Organic Administration Act, Locatable Regulations (36 CFR 228 Subpart A), and Multiple-Use Mining Act is to ensure that mining

activities minimize adverse environmental effects on NFS surface resources; this includes cultural resources. The removal of the Oak Flat Federal Parcel from Forest Service jurisdiction negates the ability of the Tonto National Forest to regulate effects on these resources. If the land exchange occurs, 31 NRHP-eligible archaeological sites and one TCP within the selected lands would be adversely affected. Under Section 106 of the NHPA and its implementing regulations (38 CFR 800), historic properties leaving Federal management is considered an adverse effect, regardless of the plans for the land, meaning that, under NEPA, the land exchange would have an adverse effect on cultural resources.

The offered lands parcels would enter either Forest Service or BLM jurisdiction. Entering Federal management would offer additional protection for any cultural resources on these lands.

Effects of Forest Plan Amendment

The Tonto National Forest Land and Resource Management Plan (1985b) provides guidance for management of lands and activities within the Tonto National Forest. It accomplishes this by establishing a mission, goals, objectives, and standards and guidelines. Missions, goals, and objectives are applicable on a forest-wide basis. Standards and guidelines are either applicable on a forest-wide basis or by specific management area.

A review of all components of the 1985 forest plan was conducted to identify the need for amendment due to the effects of the project, including both the land exchange and the proposed mine plan (Shin 2019). A number of standards and guidelines (10) were identified as applicable to management of cultural resources. None of these standards and guidelines were found to require amendment to the proposed project, either on a forest-wide or management area-specific basis. For additional details on specific rationale, see Shin (2019).

Summary of Applicant-Committed Environmental Protection Measures

A number of environmental protection measures are incorporated into the design of the project (the GPO, not the land exchange) that would act to reduce potential impacts on cultural resources. These are non-discretionary measures and their effects are accounted for in the analysis of environmental consequences.

Applicant-committed environmental protection measures by Resolution Copper to reduce impacts on cultural resources are covered in detail in the Programmatic Agreement (appendix O). Specifically, Resolution Copper would do the following:

- Develop and implement treatment plans to resolve adverse effects on cultural resources from the project. Plans would be prepared to address adverse effects on historic properties, including archaeological sites, historic buildings or structures, historic districts, and TCPs.
- Develop a monitoring and treatment plan for inadvertent discoveries. If previously unidentified cultural resources are discovered during construction activities on Tonto National Forest, work would cease within 100 feet of the location, and the Forest Service would be contacted for instruction before work would continue at that location.

3.12.4.3 Alternative 2 – Near West Proposed Action

Direct Impacts

Under Alternative 2, 132 cultural resources would be impacted: 101 NRHP-eligible and 31 undetermined archaeological sites. Ninety-six percent (10,213 acres) of the total alternative has been surveyed at the time of this review. Table 3.12.4-1 presents the number of cultural resources that are listed in or eligible for the NRHP or are of undetermined NRHP status within each project element. Some sites would be impacted by more than one project element; hence, the total numbers in the following tables are different from the total number of sites overall.

In addition, Alternative 2 would adversely impact one NRHP-listed TCP in the East Plant Site and undetermined historic buildings in the West Plant Site; this is true for Alternatives 2 through 6.

Table 3.12.4-1. Cultural resources directly impacted by Alternative 2

GPO Component	Number of NRHPListed or Eligible Sites	Number of NRHP Undetermined Sites	Total
Oak Flat Federal Parcel	31	0	**31**
East Plant Site and subsidence area	27	0	**27**
West Plant Site	9	0	**9**
Tailings facility and corridor	29	27	**56**
Silver King Mine Road realignment	7	0	**7**
MARRCO corridor	39	3	**42**
Transmission line	14	1	**15**

Note: Some sites would be impacted by more than one project element; hence, total numbers in this table are different from the total number of sites overall.

Indirect Impacts

Within the indirect impact analysis area for Alternative 2, 29 cultural resources may be impacted: two listed, eight eligible, and 19 unevaluated. Nine of those resources are within 2 miles of the tailings facility, one is within 2 miles of the East Plant Site and subsidence area (the *Chi'chil Biłdagoteel* Historic District), four are within 2 miles of the West Plant Site, one is within 2 miles of Silver King Mine Road, 12 are within 2 miles of the MARRCO corridor (including the Boyce Thompson Arboretum), and three are within 2 miles of the transmission line corridor.

Atmospheric Impacts

Outside of the proposed project footprint, but within the atmospheric analysis area of 6 miles around Alternative 2, there are 13 historic buildings or structures listed in the NRHP and 35 archaeological sites eligible for the NRHP under Criterion A, B, or C. The *Chí'chil Biłdagoteel* Historic District is less than 1 mile from the East Plant Site/subsidence area, the West Plant Site, and the Silver King to Oak Flat transmission line corridor. In addition to the historic district, one historic bridge and nine archaeological sites are also within 1 mile of the East Plant Site/subsidence area. Within 1 mile of the West Plant Site, there is one historic bridge, one hotel, and six archaeological sites, in addition to the historic district. There is one archaeological site within 1 mile of the tailings facility. One historic property and two archaeological sites are within 1 mile of Silver King Mine Road, four historic buildings and structures and 10 archaeological sites are within 1 mile of the transmission line corridor, and one historic building and five archaeological sites are within 1 mile of the MARRCO corridor. Table 3.12.4-2 gives the numbers of historic properties listed in or eligible for listing in the NRHP under Criterion A, B, or C. Please note that some properties would be impacted by more than one project component.

Table 3.12.4-2. Historic properties within the atmospheric analysis area for Alternative 2

Facility	Historic Properties within 1 mile	Historic Properties within 1 to 3 miles	Historic Properties farther than 3 miles
East Plant Site and subsidence area	11	9	33
West Plant Site	9	11	39
Tailings facility and corridor	1	6	46
Silver King Mine Road realignment	3	13	41
Silver King to Oak Flat transmission line	14	10	34
MARRCO corridor, including filter plant	6	17	36

Note: Some sites may be located by more than one project element; hence, total numbers in this table are different from the total number of sites overall.

3.12.4.4 Alternative 3 – Near West – Ultrathickened

Direct Impacts

The direct impacts of Alternative 3 on cultural resources are the same as Alternative 2.

Indirect Impacts

The indirect impacts of Alternative 3 on cultural resources are the same as Alternative 2.

Atmospheric Impacts

The atmospheric impacts of Alternative 3 on cultural resources are the same as Alternative 2.

3.12.4.5 Alternative 4 – Silver King

Direct Impacts

Seventy-two percent (8,231 acres) of Alternative 4 has been surveyed at the time of this review. Under Alternative 4, 137 cultural resources would be adversely impacted: 122 NRHP-eligible and 15 undetermined archaeological sites. Table 3.12.4-3 presents numbers of cultural resources that are listed in or eligible for the NRHP or are of undetermined NRHP status within each project element. Alternative 4 would adversely impact four more NRHP-eligible or undetermined sites than Alternative 2 or 3. Some sites would be impacted by more than one project element; hence, the total numbers in the tables are different from the total number of sites overall.

Indirect Impacts

Within the indirect impact analysis area for Alternative 4, 25 cultural resources may be impacted: two listed, 11 eligible, and 12 unevaluated. Five of those resources are within 2 miles of the tailings facility, one is within 2 miles of the East Plant Site and subsidence area (the *Chí'chil*

Table 3.12.4-3. Cultural resources directly impacted by Alternative 4

Facility	Number of NRHP-Listed or Eligible Sites	Number of NRHP-Undetermined Sites	Total
Oak Flat Federal Parcel	31	0	**31**
East Plant Site and subsidence area	27	0	**27**
West Plant Site	12	2	**14**
Silver King tailings facility and corridor/ pipeline corridor	50	10	**60**
MARRCO corridor	39	3	**42**
Filter plant and loadout facility	2	0	**2**
Transmission line	14	1	**15**
Roads	3	0	**3**

Note: Some sites would be impacted by more than one project element; hence, total numbers in this table are different from the total number of sites overall.

Biłdagoteel Historic District), four are within 2 miles of the West Plant Site, one is within 2 miles of the access roads, 12 are within 2 miles of the MARRCO corridor (including the Boyce Thompson Arboretum), one is within 2 miles of the pipeline corridor, and three are within 2 miles of the transmission line corridors.

Atmospheric Impacts

For Alternative 4, the atmospheric impacts on all project components except for the Silver King tailings facility and pipeline corridor are the same as Alternative 2. For the Silver King tailings facility and pipeline corridor, the Magma Hotel and three archaeological sites are within 1 mile, four historic buildings and 12 archaeological sites are between 1 and 3 miles, and 13 historic buildings or structures and 35 archaeological sites are more than 3 miles from the tailings facility and pipeline corridor.

Table 3.12.4-4. Cultural resources directly impacted by Alternative 5 with the east pipeline route

Facility	Number of NRHP-Listed or Eligible Sites	Number of NRHP-Undetermined Sites	Total
Oak Flat Federal Parcel	31	0	**31**
East Plant Site and subsidence area	27	0	**27**
West Plant Site	12	2	**14**
Peg Leg tailings facility and corridor/ east pipeline	72	18	**90**
Silver King Mine Road realignment	7	0	**7**
MARRCO corridor	39	3	**42**
Transmission line	14	1	**15**
Roads	0	9	**9**

Note: Some sites would be impacted by more than one project element; hence, total numbers in this table are different from the total number of sites overall.

3.12.4.6 Alternative 5 – Peg Leg

Direct Impacts

For Alternative 5, there are two potential pipeline corridor routes: an east route option and a west route option. Please note that pipeline routes have not been entirely surveyed yet; additional data may change the numbers in the following analysis. For the east pipeline route, 78 percent (13,905 acres) of the entire alternative has been surveyed; for the west pipeline route, 74 percent (13,497 acres) has been surveyed. Under Alternative 5 with the east pipeline route, 152 cultural resources would be adversely impacted: 125 NRHP-eligible and 27 undetermined archaeological sites. Under Alternative 5 with the west pipeline route, 125 cultural resources would be adversely impacted: 114 NRHP-eligible and 11 undetermined.

Tables 3.12.4-4 and 3.12.4-5 present numbers of cultural resources that are listed in or eligible for the NRHP or are of undetermined NRHP status for each pipeline corridor route. Alternative 5 with the east

Table 3.12.4-5. Cultural resources directly impacted by Alternative 5 with the west pipeline route

Facility	Number of NRHP-Listed or Eligible Sites	Number of NRHP-Undetermined Sites	Total
Oak Flat Federal Parcel	31	0	**31**
East Plant Site and subsidence area	27	0	**27**
West Plant Site	12	2	**14**
Peg Leg tailings facility and corridor/ west pipeline	66	9	**75**
Silver King Mine Road realignment	7	0	**7**
MARRCO corridor	39	3	**42**
Transmission line	14	1	**15**
Roads	0	0	**0**

Note: Some sites would be impacted by more than one project element; hence, total numbers in this table are different from the total number of sites overall.

pipeline route would impact 30 more sites than Alternative 2 or 3, and 15 more than Alternative 4. Alternative 5 with the west pipeline route would impact seven fewer than Alternative 2 or 3, and 12 fewer than Alternative 4.

Indirect Impacts

Within the indirect impact analysis area for Alternative 5 with the east pipeline route, 44 cultural resources may be impacted: two listed, 23 eligible, and 19 unevaluated. Four resources are within 2 miles of the West Plant Site, one is within 2 miles of the East Plant Site and subsidence area (the *Chí'chil Biłdagoteel* Historic District), nine are within 2 miles of the access roads, 12 are within 2 miles of the MARRCO corridor (including the Boyce Thompson Arboretum), 18 are within 2 miles of the pipeline corridor, one is within 2 miles of Silver King Mine Road, and three are within 2 miles of the transmission line corridors.

Within the indirect impact analysis area for Alternative 5 with the west pipeline route, 29 cultural resources may be impacted: one listed, 16 eligible, and 12 unevaluated. Four resources are within 2 miles of the West Plant Site, 12 is within 2 miles of the MARRCO corridor (including the Boyce Thompson Arboretum), 12 are within 2 miles of the pipeline corridor, one is within 2 miles of Silver King Mine Road, and three are within 2 miles of the transmission line corridors.

Atmospheric Impacts

For Alternative 5 with the east pipeline option, no historic properties listed or eligible for listing under Criterion A, B, or C are within 1 mile of the Peg Leg tailings facility, one historic building and six archaeological sites are within 1 mile of the pipeline corridor, six historic buildings or structures and 12 archaeological sites are within 1 to 3 miles of the tailings facility and pipeline corridor, and 13 historic buildings or structures and 35 archaeological sites are within 6 miles of the facility and pipeline corridor. One archaeological site is within 1 mile of a planned access road, and two historic buildings or structures and two archaeological sites are within 1 to 3 miles of the access road. However, no indirect impacts are expected from the access road.

For Alternative 5 with the west pipeline option, no historic properties listed or eligible under Criterion A, B, or C are within 1 mile of the Peg Leg tailings storage facility, one historic building and four archaeological sites are within 1 mile of the pipeline corridor, five historic buildings or structures and 11 archaeological sites are within 1 to 3 miles of the tailings and pipeline corridor, and 13 historic buildings or structures and 35 archaeological sites are within 6 miles of the facility and pipeline corridor. For the access road, one archaeological site is within 1 mile, and one historic building and one archaeological site are within 1 to 3 miles. However, no indirect impacts are expected from the access road.

Table 3.12.4-6. Cultural resources directly impacted under Alternative 6 with the north pipeline route

Facility	Number of NRHP-Listed or Eligible Sites	Number of NRHP-Undetermined Sites	Total
Oak Flat Federal Parcel	31	0	**31**
East Plant Site and subsidence area	27	0	**27**
West Plant Site	12	2	**14**
Skunk Camp tailings facility and corridor/ north pipeline*	252	1	**253**
Skunk Camp transmission line	12	0	**12**
Silver King Mine Road realignment	7	0	**7**
MARRCO corridor	39	3	**42**
Transmission line	14	1	**15**
Roads	8	0	**8**

Note: Some sites would be impacted by more than one project element; hence, total numbers in this table are different from the total number of sites overall.
* Numbers represent surveyed portion of pipeline corridor only.

Table 3.12.4-7. Cultural resources directly impacted under Alternative 6 with the south pipeline route

Facility	Number of NRHP-Listed or Eligible Sites	Number of NRHP-Undetermined Sites	Total
Oak Flat Federal Parcel	31	0	**31**
East Plant Site and subsidence area	27	0	**27**
West Plant Site	12	2	**14**
Skunk Camp tailings facility and corridor/ south pipeline	286	15	**301**
Silver King Mine Road realignment	7	0	**7**
MARRCO corridor	39	3	**42**
Transmission line	23	1	**24**
Roads	6	0	**6**

Note: Some sites would be impacted by more than one project element; hence, total numbers in this table are different from the total number of sites overall.

3.12.4.7 Alternative 6 – Skunk Camp

Direct Impacts

For Alternative 6, there are two potential pipeline routes: a north route option and a south route option. Under Alternative 6 with the north pipeline, 323 cultural resources would be adversely impacted: 318 NRHP-eligible and five undetermined archaeological sites. Under Alternative 6 with the south pipeline, 360 cultural resources would be adversely impacted: 343 NRHP-eligible and 17 undetermined archaeological sites. Tables 3.12.4-6 and 3.12.4-7 present NRHP-eligible and undetermined archaeological sites within Alternative 6 by pipeline route. This alternative would impact a minimum of 193 more sites than Alternative 2, 3, 4, or 5.

Please note that portions of the proposed pipeline corridors for the Skunk Camp alternative have not been completely surveyed. At this time, 16,049 acres (96 percent) of the alternative has been surveyed for Alternative 6 and the north pipeline route option, and 16,559 acres (96 percent) has been surveyed for Alternative 6 and the south pipeline route option.

Indirect Impacts

Within the indirect impact analysis area for Alternative 6 with the north pipeline route, 25 cultural resources may be impacted: two listed, 12 eligible, and 11 unevaluated. Four resources are within 2 miles of the West Plant Site, one is within 2 miles of the East Plant Site and subsidence area (the *Chí'chil Biłdagoteel* Historic District), one (The Eleven Arches) is within 2 miles of the tailings facility, five are within 2 miles of the access roads, 12 are within 2 miles of the MARRCO corridor (including the Boyce Thompson Southwest Arboretum), six are within 2 miles of the pipeline corridor, one is within 2 miles of Silver King Mine Road, one is within 2 miles of the Skunk Camp transmission line corridor, and three are within 2 miles of the transmission line corridors.

Within the indirect impact analysis area for Alternative 6 with the south pipeline route, 41 cultural resources may be impacted: two listed, 19 eligible, and 20 unevaluated. Four resources are within 2 miles of the West Plant Site, one is within 2 miles of the East Plant and subsidence area (the *Chí'chil Biłdagoteel* Historic District), one (The Eleven Arches) is within 2 miles of the tailings facility, two are within 2 miles of the access roads, 12 are within 2 miles of the MARRCO corridor (including the Boyce Thompson Arboretum), 21 are within 2 miles of the pipeline corridor, one is within 2 miles of Silver King Mine Road, and four are within 2 miles of the transmission line corridors.

Atmospheric Impacts

For Alternative 6 with the north pipeline, six historic buildings or structures and five archaeological sites are within 1 mile of the Skunk Camp tailings facility and pipeline corridor, 21 historic properties are within 1 to 3 miles, and 45 historic properties are over 3 miles. Two historic buildings or structures and five archaeological sites are within 1 mile of planned access roads, and 23 historic properties are within 1 to 3 miles of the access roads. However, no visual impacts are anticipated from access roads.

For Alternative 6 with the south pipeline, six historic buildings or structures and four archaeological sites are within 1 mile of the Skunk Camp tailings facility and pipeline corridor, 22 historic properties are within 1 to 3 miles, and 45 historic properties are over 3 miles. Two historic buildings or structures and five archaeological sites are within 1 mile of planned access roads, and 14 historic properties are within 1 to 3 miles of the access roads. However, no visual impacts are anticipated from access roads.

3.12.4.8 Cumulative Effects

The Tonto National Forest identified the following reasonably foreseeable future actions as likely, in conjunction with development of the Resolution Copper Mine, to contribute to cumulative impacts on archaeological sites and other resources of traditional, cultural, or religious importance within the analysis area identified in section 3.12.2.1. As noted in section 3.1, past and present actions are assessed as part of the affected environment; this section analyzes the effects of any RFFAs, to be considered cumulatively along with the affected environment and Resolution Copper Project effects.

- *Pinto Valley Mine Expansion.* The Pinto Valley Mine is an existing open-pit copper and molybdenum mine located approximately 8 miles west of Miami, Arizona, in Gila County. Pinto Valley Mining Corporation is proposing to expand mining activities onto an estimated 1,011 acres of new disturbance (245 acres on Tonto National Forest land and 766 acres on private land owned by Pinto Valley Mining Corporation) and extend the life of the mine to 2039. An EIS for this proposed action is currently being developed by the Tonto National Forest, and cultural resource surveys of the proposed action and alternative facility locations are concurrently being conducted. However, potential impacts on specific cultural sites are not yet known.
- *Ripsey Wash Tailings Project.* Mining company ASARCO is planning to construct a new tailings storage facility to support its Ray Mine operations. The environmental effects of the

project were analyzed in an EIS conducted by the USACE and approved in a ROD issued in December 2018. As approved, the proposed tailings storage facility project would occupy an estimated 2,574 acres and be situated in the Ripsey Wash watershed just south of the Gila River approximately 5 miles west-northwest of Kearny, Arizona. As documented in the EIS and ROD, construction of the approved tailings storage facility would adversely and directly affect 22 NRHP-eligible sites and also indirectly affect two historic properties eligible for listing in the NRHP.

- *Ray Land Exchange and Proposed Plan Amendmen*t. ASARCO is also seeking to complete a land exchange with the BLM by which the mining company would gain title to approximately 10,976 acres of public lands and federally owned mineral estate located near ASARCO's Ray Mine in exchange for transferring to the BLM approximately 7,304 acres of private lands, primarily in northwestern Arizona. The land exchange would adversely impact 58 cultural resources because those resources would be leaving Federal management.
- *Silver Bar Mining Regional Landfill and Cottonwood Canyon Road*. A private firm, Mineral Mountain LLC, is proposing to develop a landfill on land the company owns approximately 6 miles southeast of Florence Junction and 4 miles due east of SR 79. This private property is an inholding within an area of BLM-administered lands and cannot be accessed without crossing BLM land. The company received Master Facility Plan Approval for the proposed landfill from ADEQ in 2009 and a BLM right-of-way grant in 2017. As noted in the EA and FONSI for the right-of way, road improvements to allow for heavy truck haul traffic across BLM lands would adversely affect six cultural sites. Of the six sites, three are presently of unknown eligibility and would require eligibility testing; the other three sites have been recommended eligible for the NRHP and would require data recovery. Additionally, one cultural resource site that is outside the area of potential effects, but sufficiently close enough that it may be impacted, has been recommended NRHP eligible.
- *Superior to Silver King 115-kV Relocation Project.* At the request of Resolution Copper, SRP intends to relocate an approximately 1-mile segment of the existing Superior-Silver King 115-kV transmission line approximately 0.25 mile to the northwest to accommodate future Resolution Copper Mine–related facilities. In this area the transmission line corridor is located entirely on Resolution Copper–owned private property. The proposed relocation of the line has the potential to affect one historic property that is recommended NRHP eligible and may also impact other, as-yet-unknown archaeological sites.
- *Tonto National Forest Plan Amendment and Travel Management Plan.* The Tonto National Forest is currently in the process of revising its Forest Plan to replace the plan now in effect, which was implemented in 1985. Simultaneously, the Tonto National Forest is developing a Supplemental EIS to address certain court-identified deficiencies in its 2016 Final Travel Management Rule EIS. Both documents and their respective implementing decisions are expected within the next 2 years. Cultural resources may be impacted for any new road construction; however, the Tonto National Forest would conduct the appropriate surveys, consultation, and mitigation. Impacts on these sites would cumulatively impact cultural resources in the area in combination with the loss of sites that would take place with the Resolution Copper Project.

Other ongoing and future mining activity, infrastructure improvement projects (including construction of new roadways, water and sewer systems, power transmission lines, and other utilities), and private and commercial land development is likely to occur in this area of south-central Arizona during the foreseeable future life of the Resolution Copper Mine (50–55 years). Each of these developments may contribute, both individually and cumulatively, to adverse effects on prehistoric and historic archaeological sites and other places of cultural importance.

3.12.4.9 Mitigation Effectiveness

Mitigation of adverse effects on historic properties eligible for the NRHP under Criterion D, the potential to provide significant information about the past, most often consists of data recovery to gather the information prior to disturbance. A Programmatic Agreement (see appendix O) is currently being developed to address adverse effects on historic properties under Section 106 of the NHPA. Mitigation of adverse effects on historic properties eligible for the NRHP under Criterion A, B, or C would be developed in consultation with the appropriate Indian Tribes, SHPO, and other interested parties and would be outlined in a historic properties treatment plan and/or a TCP Redress Plan as stipulated by the PA. Mitigation of adverse impacts under NEPA that do not fall under Section 106 would also be developed in consultation with the tribes and interested parties. Data recovery is generally considered an effective mitigation for historic properties eligible for the NRHP for their information potential; however, mitigation strategies for historic properties eligible under other criteria may or may not be completely effective.

The Forest Service is in the process of developing a robust mitigation plan to avoid, minimize, rectify, reduce, or compensate for resource impacts that have been identified during the process of preparing this EIS. Appendix J contains descriptions of mitigation concepts being considered and known to be effective, as of publication of the DEIS. Appendix J also contains descriptions of monitoring that would be needed to identify potential impacts and mitigation effectiveness. As noted in chapter 2 (section 2.3), the full suite of mitigation would be contained in the FEIS, required by the ROD, and ultimately included in the final GPO approved by the Forest Service. Public comment on the EIS, and in particular appendix J, will inform the final suite of mitigations.

Mitigation Measures Applicable to Cultural Resources

Conduct cultural and archaeological data recovery via the Oak Flat HPTP (RC-209): The Oak Flat Historic Properties Treatment Plan (HPTP) sets out a plan for treatments to resolve the adverse effects on 42 historic properties that have been identified within the Oak Flat Federal Parcel. In accordance with the plan, Resolution Copper would conduct archaeological data recovery on sites eligible under Criterion D that would be adversely affected. Project materials and archaeological collections would be curated in accordance with 36 CFR 79 (Curation of Federally-Owned and Administered Archaeological Collections) with Gila River Indian Community, Salt River Pima-Maricopa Indian Community, and the Arizona State Museum. This measure is applicable to all alternatives and would be noted in the ROD/Final Mining Plan of Operations.

Conduct cultural and archaeological data recovery via the Research Design and data recovery plans (RC-210): The GPO Research Design and data recovery plans detail treatments to resolve adverse effects on historic properties within the GPO project area with the exception of those in the Oak Flat Federal Parcel. Data recovery would be conducted on archaeological sites eligible under Criterion D within the GPO project area. Project materials and archaeological collections would be curated in accordance with 36 CFR 79 (Curation of Federally-Owned and Administered Archaeological Collections) with Gila River Indian Community, Salt River Pima-Maricopa Indian Community, and the Arizona State Museum. This measure is applicable to all alternatives and would be noted in the ROD/Final Mining Plan of Operations.

Mitigation Effectiveness and Impacts

Archaeological data recovery can reduce a portion of the adverse effect by sampling historic properties that are eligible for their scientific information potential under Criterion D of the NRHP. However, there are several limitations to data recovery's effectiveness. Data recovery by nature is destructive, and although archaeological investigative techniques are continually evolving, even today's state-of-the-art research strategies would not be able to recover all the data potential at the project area sites. Data recovery can record and preserve some of the materials from the sites, but it cannot preserve the current integrity of setting, association, workmanship, feeling, location, and design.

Unavoidable Adverse Effects

Cultural resources and historic properties and uses would be directly and permanently impacted. These impacts cannot be avoided within the areas of surface disturbance, nor can they be fully mitigated. The land exchange is also considered an unavoidable adverse effect on cultural resources.

3.12.4.10 Other Required Disclosures

Short-Term Uses and Long-Term Productivity

Physical and visual impacts on archaeological sites, tribal sacred sites, cultural landscapes, and plant and mineral resources caused by construction of the mine would be immediate, permanent, and large in scale. Mitigation measures cannot replace or replicate the historic properties that would be destroyed by project construction. The landscape, which is imbued with specific cultural attributions by each of the consulted tribes, would also be permanently affected.

Irreversible and Irretrievable Commitment of Resources

The direct impacts on cultural resources and historic properties from construction of the mine and associated facilities constitute an irreversible commitment of resources. Archaeological sites cannot be reconstructed once disturbed, nor can they be fully mitigated. Sacred springs would be eradicated by subsidence or tailings storage facility construction and affected by groundwater water drawdown. Changes that permanently affect the ability of tribal members to use known TCPs for cultural and religious purposes are also an irreversible commitment of resources.

Overview

Large mines can be a boon to local economies through the influx of employees, spending on products and services, and increased tax revenue. These same increases can also stress basic services like hospitals, water and sewer systems, local housing stock, and roads and infrastructure. A large mine (or tailings facility) can also fundamentally change the quality of life of the surrounding communities, affect property values, and affect other industries, such as tourism and recreation. Historically, mining in Arizona has followed a “boom and bust” cycle, which potentially leads to great economic uncertainty.

3.13 Socioeconomics

3.13.1 Introduction

The analysis for social and economic concerns includes a discussion of current social and economic data relevant to the proposed project, including population, housing, financial resources, facilities and services, and quality of life. These elements are considered to help analyze potential impacts from the proposed project and alternatives to social and/or economic conditions. Further detail regarding the social and economic information is provided in “Socioeconomic Effects Technical Report: Resolution Copper Mine Environmental Impact Statement” (BBC Research and Consulting 2018). Potential socioeconomic impacts analyzed in this section include employment, earnings, state and local government revenue, demands for public services, risk of a mining boom/bust cycle, tourism, and property values.

3.13.2 Analysis Methodology, Assumptions, and Uncertain and Unknown Information

3.13.2.1 Analysis Area

The socioeconomic analysis focused primarily on the region informally known as the “Copper Triangle,” which encompasses the location of the proposed mine, and most closely examined potential effects in the town of Superior, which is the closest community. Other communities within the Copper Triangle include the Queen Valley Census Designated Place (CDP), Cutter CDP, city of Globe, town of Hayden, town of Miami, San Carlos CDP, Bylas CDP, Peridot CDP, Top-of-the-World CDP, and town of Winkelman. Whereas most of the Copper Triangle is located in Pinal and Gila Counties, Maricopa County was also included in the socioeconomic analysis because a substantial portion of the workforce for the proposed mine would be expected to commute from the Phoenix metropolitan area. Pima County is farther from the proposed mine and unlikely to be substantially affected by construction or operations but was included in the regional economic impact analysis (section 3.13.4) based on information indicating suppliers in Pima County would likely provide goods and services to support mining activity.

3.13.2.2 Analysis Methodology

Information regarding the social and economic affected environment was obtained from various sources, including the following: the U.S. Census Bureau; the State of Arizona; Impact Analysis for Planning (IMPLAN) data files;[70] Gila, Graham, Maricopa, Pima, and Pinal Counties; and the Town of Superior. Information on the potential social and economic effects of the proposed alternatives was based primarily on IMPLAN economic input-output analysis. This modeling incorporated the proposed GPO provided by Resolution Copper, current tax rates and tax policies of the relevant jurisdictions, interviews with local information

70. IMPLAN is a widely used economic model and is used to quantify the direct and indirect economic effects of a project.

Primary Legal Authorities Relevant to the Socioeconomics Effects Analysis
• National Forest Management Act
• Tonto National Forest Land and Resource Management Plan
• Forest Service Economic and Social Analysis Handbook (FSH 1909.17)
• Chapter 1970, Social and Economic Evaluation (FSM 1970.1)

sources, and information provided by the AGFD. The temporal bounds of analysis for socioeconomic resources is the three phases of activity associated with the mine: construction, operations, and closure/reclamation. The spatial analysis area for socioeconomics includes the communities most likely to be affected by the proposed project (figure 3.13.2-1).

Where the employees of the proposed mine would choose to reside is an important uncertainty in this evaluation. The future price of copper over the projected life of the proposed mine is unknown, as well. Both of these issues are evaluated in detail in BBC Research and Consulting (2018).

3.13.3 Affected Environment

One of the planning principles in the National Forest Management Act is "responsiveness to changing conditions in the land and changing social and economic demands of the American people" (U.S. Forest Service 1985b). Forest Service guidelines for socioeconomic analyses are outlined in the Forest Service "Economic and Social Analysis Handbook" (U.S. Forest Service 1985a). The handbook provides guidelines for evaluating socioeconomic impacts that may result from policy, program, plan, or project decisions on NFS lands. Forest Service Manual 1970.1 directs how economic and social analyses should be conducted to aid Forest Service decision-making.

3.13.3.1 Relevant Laws, Regulations, Policies, and Plans

A complete listing and brief description of the legal authorities, reference documents, and agency guidance applicable to socioeconomics may be reviewed in Newell (2018f).

3.13.3.2 Existing Conditions and Ongoing Trends

Demographic and Socioeconomic Characteristics

Population. The population of the State of Arizona was approximately 6.9 million in 2016. In 2016, the counties closest to the proposed mine site (Pinal, Graham, and Gila Counties) had populations of 417,540 (Pinal), 37,407 (Graham), and 53,556 (Gila). Between 2000 and 2016, Pinal County's population grew at an average annual rate of 5.4 percent, compared with a rate of 0.3 percent in Gila County and 0.7 percent in Graham County. The population of Maricopa County, which lies approximately 60 miles west of the town of Superior, was 4.2 million in 2016 and grew at an average annual rate of 2.0 percent between 2000 and 2016.

The town of Superior had 2,999 residents in 2016, which represents an increase of 166 residents since 2010 (5.9 percent growth), but a decline of 525 residents since 2000 (14.9 percent reduction). In total, the Copper Triangle had approximately 50,000 residents in 2016.

Housing. The characteristics of the housing stock in the analysis area are shown in table 3.13.3-1. Maricopa County had the largest housing stock in the socioeconomic analysis area (an average of 1.7 million homes between 2011 and 2015). Of the remaining counties, Pinal County had the second largest housing stock (163,490 housing units), followed by Gila County (32,952 housing units), and Graham County (13,128

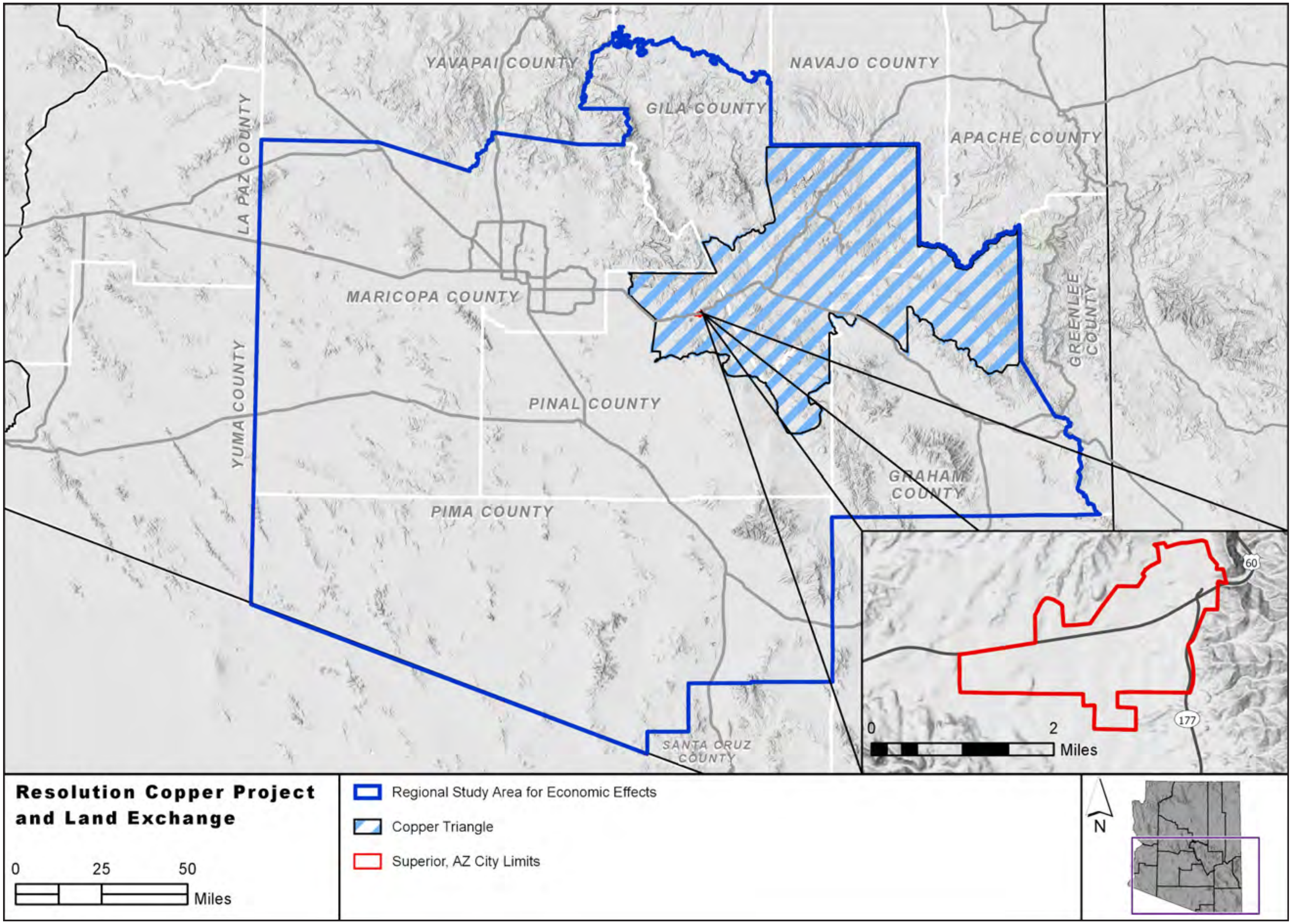


Figure 3.13.2-1. Socioeconomic resource analysis area

Table 3.13.3-1. Housing characteristics of the socioeconomic analysis area, 2011–2015

Area	Average Housing Stock	Change in Housing Stock (%)*	Average Vacant Units	Average Vacancy Rate (%)
Gila County	**32,952**	**16.9**	**12,043**	**36.5**
Cutter	19	–	0	0.0
Globe	3,356	5.8	516	15.4
Hayden	301	−9.9	85	28.2
Miami	988	6.2	195	19.7
San Carlos	1,160	16.7	178	15.3
Graham County	**13,128**	**14.9**	**2,169**	**16.5**
Bylas	474	–	78	16.5
Peridot	395	9.1	63	15.9
Maricopa County	**1,668,555**	**33.5**	**226,037**	**13.5**
Pinal County	163,490	101.5	35,891	22.0
Superior	1,284	−12.7	319	24.8
Top-of-the-World	128	−44.7	55	43.0
Winkelman	152	−21.6	39	25.7
Arizona	***2,890,664***	***32.0***	***478,452***	***16.6***

Sources: U.S. Census Bureau (2000); U.S. Census Bureau ACS 5-year estimates, 2011 to 2015 (U.S. Census Bureau 2015b).

* Percentage change was calculated with data from the 2000 U.S. Census and the ACS 5-year estimates from 2011 to 2015. Information on the housing stocks of Cutter and Bylas was not available for the year 2000.

housing units). The town of Superior had an average housing stock of 1,284 units between 2011 and 2015.

Between 2011 and 2015, there was an average of 226,037 vacant housing units in Maricopa County, compared with 35,891 in Pinal County, 12,043 in Gila County, and 2,169 in Graham County. The town of Superior had an average of 319 vacant housing units during this time. The vacancy rate in Superior (24.8 percent) was about 8 percentage points higher than the average vacancy rate across Arizona (16.6 percent).

Maricopa County had the highest median home values between 2011 and 2015 ($187,100), followed by Gila County ($134,200) and Pinal County ($128,700). Of the cities and towns in the socioeconomic analysis area, Globe had the highest median home values between 2011 and 2015 ($116,500), followed by Superior ($78,200) and Miami ($65,800). Hayden had the lowest median home values between 2011 and 2015 ($32,900), followed by Bylas ($46,700).

Employment. In 2015, there were approximately 2.4 million jobs in Maricopa County, compared with 90,119 jobs in Pinal County, 21,382 jobs in Gila County, and 11,921 jobs in Graham County. The retail trade sector was the largest source of employment in all four counties. While the mining industry is not among the largest employers in the socioeconomic analysis area, the industry still employed a total of 10,670 people across all four counties in 2015. In percentage terms, Pinal County saw the largest change in employment between 2001 and 2015 (approximately 65 percent), followed by Maricopa County (28 percent), Graham County (23 percent), and Gila County (7 percent).

Labor force, unemployment, and income characteristics. The labor force in each county, city, and town in the socioeconomic analysis area is shown for the year 2000 and the period from 2011 to 2015 in table 3.13.3-2. Between 2011 and 2015, there was an average of approximately 2.0 million workers in Maricopa County, compared with 150,351 workers in Pinal County, 20,607 workers in Gila County, and 13,919 workers in Graham County. Between 2011 and 2015, the average unemployment rate was 6.1 percent in Gila County, 6.9 percent in Graham County, 4.9 percent in Maricopa County, and 5.3 percent in

Table 3.13.3-2. Average labor force, unemployment rate, and median household income in the socioeconomic analysis area, 2011–2015

Area	Labor Force	Unemployment Rate (%)	Median Household Income ($)
Gila County	**20,607**	**6.1**	**39,751**
Cutter	40	18.9	–
Globe	3,539	5.3	42,405
Hayden	244	13.6	38,167
Miami	897	5.6	40,602
San Carlos	1,304	15.5	25,363
Graham County	**13,919**	**6.9**	**45,964**
Bylas	727	31.7	24,028
Peridot	767	25.8	40,500
Maricopa County	**1,977,494**	**4.9**	**54,229**
Pinal County	150,351	5.3	49,477
Superior	1,238	5.6	41,367
Top-of-the-World	111	10.8	77,689
Winkelman	136	5.6	41,250
Arizona	***3,106,324***	***5.3***	***50,255***

Source: U.S. Census Bureau (2015a).

Pinal County. The average unemployment rate in the town of Superior was 5.6 percent during this time. Between 2011 and 2015, the median household income in Graham County was $45,964, compared with $54,229 in Maricopa County. During the same period, the median household income in Pinal County was $49,477. In Gila County, the median household income was $39,751. The town of Superior had a median household income of approximately $41,000 between 2011 and 2015.

County taxes, revenues, and public expenditures. Table 3.13.3-3 shows the sources of revenue for Gila, Graham, Maricopa, and Pinal County Governments for the most recent fiscal years for which data are available. Taxes, including property, income, sales, and vehicle license taxes, accounted for 52.1 percent of Gila County's tax revenues in fiscal year (FY) 2014, compared with 44.8 percent in Graham County, 87.4 percent in Maricopa County in FY 2015, and 60.9 percent in Pinal County in FY 2015. Grants, including unrestricted and operating grants, and other sources of revenue were the other primary contributors of county government tax revenues. General government expenses, public

Table 3.13.3-3. General revenues and expenditures for Gila, Graham, Maricopa, and Pinal County governments

General Revenues	FY 2014 Gila County (%)	FY 2014 Graham County (%)	FY 2015 Maricopa County (%)	FY 2015 Pinal County (%)
Taxes	52.1	44.8	87.4	60.9
Intergovernmental	0.0	0.0	0.0	31.1
Charges for services	4.9	12.0	0.0	5.1
Grants	31.1	28.7	0.2	0.0
Other	11.9	14.5	12.4	2.9
Total (Millions, $)	**$62.2**	**$30.7**	**$1,385.4**	**$148.3**
General Expenditures				
General government	34.2	30.4	14.9	22.9
Public safety	26.4	34.4	55.2	62.7
Highway and streets	10.4	13.5	3.8	0.2
Health, welfare, and sanitation	19.1	12.2	21.2	13.5
Culture and recreation	2.4	2.8	2.9	0.0
Education	6.9	6.7	1.5	0.6
Interest	0.5	0.0	0.4	0.0
Total (Millions, $)	**$60.3**	**$32.3**	**$2,000.0**	**$153.3**

Sources: Arizona Auditor General (Arizona Auditor General 2017a, 2017b); Maricopa County (2017); and Pinal County (2016).

Note: Tax revenues include property, income, sales, and vehicle license taxes.

Table 3.13.3-4. General revenue and expenditures for the Town of Superior

General Revenues	Percentage of Total	General Expenditures	Percentage of Total
Taxes	53.2	General government	32.2
Intergovernmental	41.1	Public works	47.8
Charges for services	1.8	Welfare	5.2
Grants	0.0	Culture and recreation	4.9
Other	3.9	Other	9.9
Total (Millions, $)	**$2.0**	**Total (Millions, $)**	**$1.8**

Source: HintonBurdick CPAs and Advisors (2017)

safety, highways and streets, and health, welfare, and sanitation were the primary categories of expenditures in all four counties.

Town of Superior taxes, revenues, and public expenditures. Table 3.13.3-4 shows the sources of revenue for the Town of Superior government during FY 2015 (July 1, 2015–June 30, 2016). During that time, the Town of Superior received approximately $2.0 million in revenue. The largest share of revenue collected came from taxes (53.2 percent). The largest expenditures made were for public works, which accounted for 47.8 percent of the Town's expenditures.

Public Facilities and Services

Transportation and road maintenance. The town of Superior can be accessed by road via U.S. 60, which is a major east-west transportation route through the region, and SR 177, which is a north-south route that runs between Superior and the town of Winkelman. Superior also has 25.6 miles of local streets that connect the town's different neighborhoods. A 2009 study commissioned by ADOT found that the 16-mile stretch of U.S. 60 between Superior and Miami/Globe was operating at capacity and expected the level of service to decline over time unless improvements were made to accommodate future demand (Logan Simpson Design Inc. 2009). A 2016 assessment of Superior's roads found that of the 25.6 miles of roads maintained by the Town, 17 miles were in poor or serious condition (Arizona Department of Transportation 2016). Estimates suggest it would cost the Town $1.25 million to repair all the roads in need of improvements.

Utility services. The Town of Superior contracts with the Arizona Water Company to supply the Town's municipal water. Arizona Water Company supplies Superior with municipal drinking water from Arizona Water Company's groundwater resources located near Florence Junction. Arizona Water Company recently petitioned the Arizona Corporation Commission to raise water rates in the town of Superior, citing the need to raise revenue to cover investments in infrastructure as well as increasing operating and maintenance expenses. The Town of Superior provides sewer and wastewater treatment services for its residents. A recent study of the Town's wastewater treatment plant, originally built in 1974, found several inadequacies and noted that the plant may not meet State inspection standards (Duthie Government Advisors 2016). The Town has recently received a grant from the USDA to upgrade the wastewater treatment system (Jeavons 2018). Electricity is provided by APS.

Emergency and medical services. The Town of Superior funds and operates both fire and police departments. According to conversations with the Town's Fire Chief, the fire department has six full-time staff and 24 reserve staff that are paid on a per-call basis. The fire department has two type-1 engines, which are used for structure fires, one 1,800-gallon water tender, a type-6 brush truck used for fighting wildfires, and two rescue vehicles. The Town's police department has nine full-time officers, seven reserve officers, and one office manager that serve Superior's population.

Travel and Tourism

In Pinal County, tourists and visitors spent a total of $207.6 million in 1998, but by 2016, visitor spending had grown to $571.6 million, an increase of 175 percent (figure 3.13.3-1). During this same period, visitor spending grew by 75 percent across the state of Arizona, while

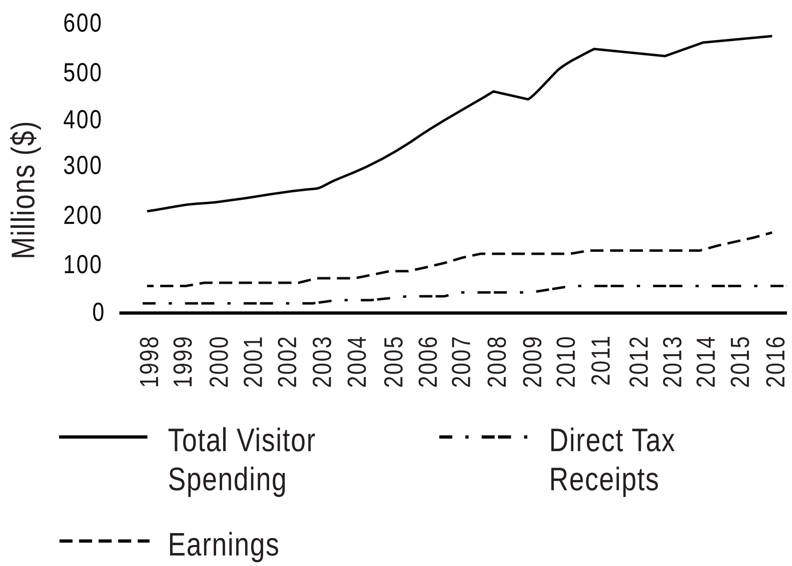


Figure 3.13.3-1. Total visitor spending, earnings, and direct tax receipts in Pinal County ($, millions). Source: reproduced from Dean Runyan Associates (2017)

visitor spending growth in Gila, Graham, Pima, and Maricopa Counties amounted to 41, 82, 36, and 88 percent, respectively. The growth in visitor spending has been supported by an increase of out-of-state air travel arrivals in Arizona. Between 2015 and 2016, air travel arrivals in the state increased by 7 percent. The growth in visitor spending helped businesses in Pinal County earn $168.4 million from visitor spending in 2016, compared with $53.7 million in 1998. Visitor spending in the county also supports county and local governments by generating tax revenues. Estimates from Dean Runyan Associates (2017) show that visitor spending generated approximately $53.2 million in tax revenue in Pinal County in 2016, which is a 197 percent increase from the tax revenue generated from visitor spending in 1998. Overall, visitor

Table 3.13.3-5. Activity participation in Tonto National Forest, 2016

Activity	% Participation	% Main Activity
Hiking/walking	29.3	15.3
Viewing wildlife	25.1	1.2
Relaxing	22.6	5.3
Viewing natural features	22.2	5.7
Fishing	17.9	11.8
Non-motorized water	14.9	13.6
Some other activity	14.5	10.9
Motorized water activities	12.5	8.5
Other non-motorized	11.1	6.7
Driving for pleasure	10.5	3.3
Developed camping	7.9	2.9
Picnicking	7.7	2.5
OHV use	7.5	5.8
Nature study	5.9	0
Primitive camping	4.1	1.1

Source: U.S. Forest Service (2016d)

spending supports an estimated 6,840 jobs in Pinal County (Dean Runyan Associates 2017). As a result, changes in visitation numbers or visitor spending in the county could have effects on the county's economy.

The tourism economy of the Copper Triangle, which includes Pinal and Gila Counties as well as the town of Superior, is dependent on natural amenities to draw visitors to the area. The southern portion of the Tonto National Forest includes areas around the town of Superior. Table 3.13.3-5 shows the primary activities of visitors to the Tonto National Forest.

In 2016, approximately 2,580,000 people visited Tonto National Forest to participate in recreation activities (U.S. Forest Service 2016d). Visitors to the Tonto National Forest spent an average of $115 per party per day on an average trip lasting approximately 4 days (U.S. Forest

Service 2016d). The Tonto National Forest is also one of the most heavily used National Forests for motorized recreation (Arizona Game and Fish Department 2018e). Statewide, OHV user spending adds $1.6 billion in value to the state's economy and sustains more than 21,077 jobs (Arizona State University 2016). In Pinal County, wildlife viewing contributes approximately $89.5 million annually to the county's economy (Arizona Game and Fish Department 2018e).

3.13.4 Environmental Consequences of Implementation of the Proposed Mine Plan and Alternatives

3.13.4.1 Alternative 1 – No Action Alternative

Under the no action alternative, the mine would not be developed, and existing socioeconomic conditions and trends would continue, as described in the "Affected Environment" part of this resource section.

3.13.4.2 Direct and Indirect Effects Common to All Action Alternatives

Effects of the Land Exchange

The land exchange would have limited effects on socioeconomics. The Oak Flat Federal Parcel would leave Federal jurisdiction and would result in a reduction of wildlife-related recreation spending and expenditures by visitors to the Oak Flat Campground, although the exact amount lost from visitors to Oak Flat has not been quantified. Another expected effect on socioeconomics could stem from slight changes in the tax base, but overall this would be limited. The admission of eight new parcels into Federal jurisdiction may increase recreational spending in those areas; however, it is likely to result in minimal overall effects. One of the planning principles in the National Forest Management Act is "responsiveness to changing conditions in the land and changing social and economic demands of the American people" (U.S. Forest Service 1985b). As such, the offered lands parcels entering NFS jurisdiction would then be managed under those principles.

Effects of Forest Plan Amendment

The Tonto National Forest Land and Resource Management Plan (U.S. Forest Service 1985b) provides guidance for management of lands and activities within the Tonto National Forest. It accomplishes this by establishing a mission, goals, objectives, and standards and guidelines. Missions, goals, and objectives are applicable on a forest-wide basis. Standards and guidelines are either applicable on a forest-wide basis or by specific management area.

A review of all components of the 1985 forest plan was conducted to identify the need for amendment due to the effects of the project, including both the land exchange and the proposed mine plan (Shin 2019). No standards and guidelines were identified as applicable to socioeconomics. For additional details on specific rationale, see Shin (2019).

Summary of Applicant-Committed Environmental Protection Measures

Resolution Copper has entered into a number of agreements that would result in socioeconomic benefits within the analysis area. These are included here and their effects are accounted for in the analysis of environmental consequences.

- In February 2019, Resolution Copper entered into an Entrepreneurship and Innovation Center Gift Agreement with the Town of Superior, to fund a number of programs meant to diversify the economic base of the community.
- In February 2019, Resolution Copper entered into a Multigenerational Center Development Gift Agreement with the Town of Superior, to help fund the final studies, design, and construction of a multigenerational center. The goal of the center is to improve the overall quality of life for Superior

residents, local employers, and their employees, expand the quality of life amenities and services that are essential to retraining and attracting residents and employers, allow for consolidation of Town services and decrease the overall administrative burden of the Town, and further develop public, private, civic, and educational sectors of the community.

- In February 2019, Resolution Copper entered into an Education Funding Agreement with the Superior Unified School District, dedicating funding to a number of classroom enhancements and educational programs over the next 4 years.
- In February 2019, Resolution Copper entered into a Park Improvement Agreement with the Town of Superior, to fund improvements to the U.S. 60 Caboose Park.
- In March 2016, Resolution Copper entered into an Emergency Response Services agreement with the Town of Superior, to fund the provision of fire and other emergency services to the mine facilities by the Town.
- Resolution Copper has committed at a corporate level to hiring qualified candidates locally, and will track progress by employee proximity to the mine.
- Resolution Copper has committed at a corporate level to using local suppliers and services wherever possible.

Socioeconomic Impacts

Most of the direct and indirect effects are based on the proposed mine plan, including employment, earnings, output, and fiscal impacts, and do not differ in nature or magnitude between the action alternatives. Two indirect effects (effects on the tourism economy and property values) are similar in nature between alternatives but differ in magnitude. The differences between each action alternative are summarized in the following tables.

Impact on employment, earnings, and value added. Table 3.13.4-1 summarizes the annual average economic and fiscal effects of the proposed mine based on projected employment and purchases of goods and services over the life of the mine. On average, the mine is projected to directly employ 1,523 workers, pay about $134 million per year in total employee compensation, and purchase about $546 million per year in goods and services (not shown in table 3.13.4-1). The IMPLAN results indicate that the proposed mine would create substantial “multiplier” effects (technically known as indirect and induced economic effects) in Arizona, supporting almost 2,200 indirect and induced jobs and about $135 million per year in indirect and induced labor income. Including direct and multiplier effects, the proposed mine is projected to increase average annual economic value added in Arizona by about $1.0 billion (not shown in table 3.13.4-1). However, most of the multiplier effects would occur outside of the “Copper Triangle.” While all of the direct mine employment is expected to be based in the ZIP code encompassing Superior, only 11 percent of the multiplier effects are projected to occur within that ZIP code. About 8 percent of the multiplier effects are projected to occur in other parts of Pinal County, about 6 percent in Gila County, and about 7 percent in Pima County. The majority of the multiplier effects are projected to occur in Maricopa County (68 percent).

Projected employment and procurement activity associated with the proposed mine is anticipated to vary over the life of the project. The largest direct employment at the proposed mine is projected to occur during the approximately 15-year period encompassing mine construction and the ramp-up to full production (potentially 2021–2035). The smallest direct employment levels, and the lowest spending on goods and services, are projected to occur during the latter years of production and the closure and reclamation phases (potentially 2056–2079), as shown in figure 3.13.4-1.

Where the mine’s employees would live is important in evaluating impacts on Superior and the Copper Triangle area in terms of demographics, demands for public services, and other social and economic effects. Based on current commuting patterns and the residence choices of the mine’s employees to date, it appears likely that

Table 3.13.4-1. Summary of IMPLAN labor results based on projected average annual activity from proposed Resolution Copper Project

Geographic Area	Employment	Labor Income
Superior (ZIP code 85173)		
Direct Effect	1,523	$133,873,199
Indirect Effect	121	$7,222,045
Induced Effect	177	$4,425,516
Total Effect	**1,820**	**$145,520,760**
Rest of Copper Triangle (Indirect and Induced Effects Only)		
Other Pinal County areas	98	$1,045,321
Gila County areas	171	$5,569,895
Graham County areas	0	$0
Total Rest of Copper Triangle	**269**	**$6,615,216**
Effects Outside of Copper Triangle *(Indirect and Induced Effects Only)*		
Pinal County (remainder)	128	$6,858,380
Gila County (remainder)	0	$0
Graham County (remainder)	0	$0
Maricopa County	1,336	$101,273,756
Pima County	149	$8,538,230
Total Effect	**1,613**	**$116,670,366**
Total Regional Effects		
Direct Effect	1,523	$133,864,394
Indirect Effect	1,175	$93,446,967
Induced Effect	1,004	$41,494,980
Total Effect	**3,702**	**$268,806,341**

Note: Rounded to nearest whole number

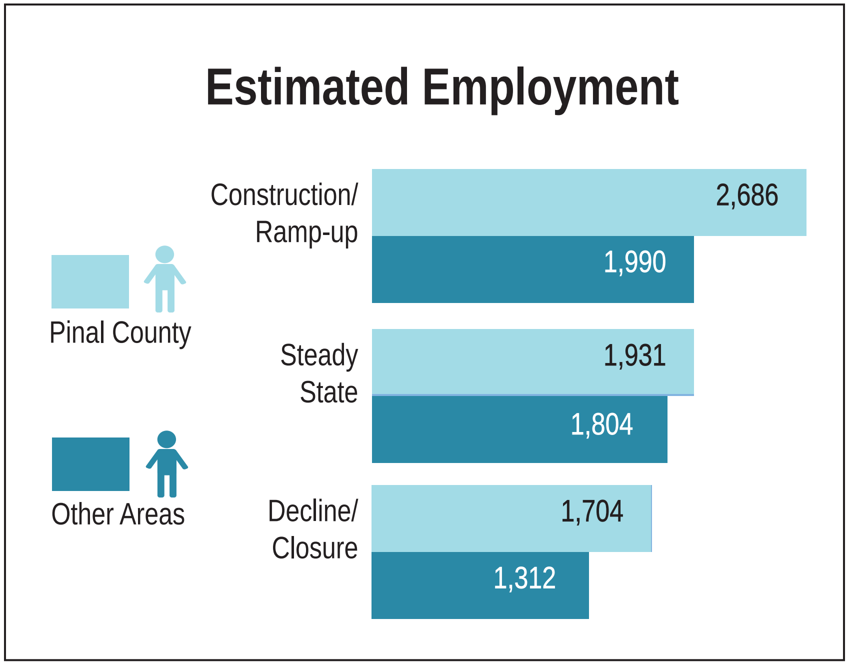


Figure 3.13.4-1. Comparison of projected total employment effects (direct and indirect/induced) during different phases of the proposed Resolution Copper Project

approximately 25 percent of the workforce would seek to live in or near Superior, and about 10 percent would choose to live in or near other communities within the Copper Triangle. The remainder would likely commute primarily from eastern portions of Maricopa County.

During the first few years, the actual number of mine-related employees who would live in Superior is likely to be constrained by the size and condition of the town's available housing supply and the availability of local services. While an estimated 455 of the new workers projected to result from the proposed mine might prefer to live nearby, given current conditions in Superior, it is more likely that these new workers would absorb about one-half of the available, move-in-ready housing stock during the early years of mine construction and operations. This implies about 150 new households would move to Superior in the relatively near term. Additional housing demand from mine-related workers is likely to provide upward pressure currently on home prices in Superior (which are currently very low), and could create affordability challenges for some existing Superior residents.

Projected fiscal effects. Operation of the proposed mine would produce both direct revenues to state and local governments (paid by Resolution Copper) and secondary revenues for those governments (which would be paid by employees and vendors). While there are numerous minor government revenues that would be generated by operation of the proposed mine, more than 95 percent of the revenues that would accrue to the State of Arizona and the most affected local governments (those within Pinal and Gila Counties) would stem from six revenue sources—some of which would produce revenues for both the State government and local governments:

- Resolution Copper property taxes (property taxes on the mine itself, paid to Pinal County and other local taxing entities)
- Resolution Copper severance taxes (paid to the State of Arizona, with a portion shared to local governments based on population)
- Resolution Copper corporate income taxes (paid to the State of Arizona, with a portion shared to cities based on population through Urban Revenue Sharing Fund)
- Transaction privilege taxes (sales taxes paid to local governments and the State of Arizona, with a portion of the State revenues shared to local governments based on population)
- Employee income taxes (paid to the State of Arizona, with a portion shared to cities based on population through Urban Revenue Sharing Fund)
- Employee property taxes (paid to the jurisdictions in which the employees would reside)

State and local government revenue summary. Combining estimated revenues from the six primary revenue sources just described, the proposed mine is projected to generate an average of between $88 and $113 million per year in State and local tax revenues, as shown in table 3.13.4-2. The reported range of annual revenues reflects differences between tax revenue projections developed by consultants for Resolution Copper and revenue projections developed for the Forest Service, as described in BBC Research and Consulting (2018). The State of Arizona would be the largest recipient of tax revenues from the proposed mine, with projected average receipts of about $34 million per year. Pinal County Junior College and Pinal County would also receive large amounts of tax revenues (ranging from about $8 million to over $18 million), primarily from property tax revenues on the proposed mine. While the Superior Unified School District would receive the largest amount of property tax revenue based on its current mill levy, the Arizona school finance equalization system would likely require the School District to either reduce its mill levy, distribute the additional tax revenues across other districts, or a combination of both. Although Superior is by far the closest municipality to the proposed mine, the Town is projected to receive a small share of the total tax revenues (less than $0.4 million per year) in the near term, but this would increase

Table 3.13.4-2. Projected average annual State and local government revenues related to the proposed Resolution Copper Project

Location	Total by Jurisdiction	
	Low Estimate ($)	High Estimate ($)
Town of Superior		
Near term	$372,529	$372,705
Longer term	$695,484	$695,660
Superior Unified School District*	19,238,311	30,087,882
Pinal County Junior College	7,605,420	11,894,545
Pinal County	11,941,974	18,507,156
Gila County	97,273	102,658
Graham County	26,737	30,481
Other Arizona jurisdictions†		
Near term	15,036,899	17,724,324
Longer term	14,713,944	17,401,369
State of Arizona	33,520,225	34,464,398
Total‡	**87,839,367**	**113,184,149**

* School district revenues based on current mill levy. Arizona school finance equalization formula would likely result in either a reduction in the mill levy or a redistribution of revenues to other districts, or both.

† Includes all Arizona municipalities other than Superior; all Arizona counties other than Pinal, Gila, and Graham; and all property-taxing entities in Pinal County other than those identified in this table.

‡ Totals shown exclude the longer term estimates for Town of Superior and other Arizona jurisdictions.

to $0.7 million per year if future development accommodates the full housing demand estimate of 455 workers living in Superior.

The proposed mine would also produce substantial revenues for the Federal Government, estimated at more than $200 million per year (Elliot D. Pollack and Company 2011). The revenues shown in table 3.13.4-2 would directly result from mine activity. However, growth in population resulting from mining activity would also lead to additional revenues from the State of Arizona's revenue sharing formulas, particularly in the town of Superior. In the near term, when current constraints would limit the number of new employees living in Superior, projected growth in Superior's population would result in an increase in intergovernmental revenue sharing from the State of approximately $125,000 per year. If and when housing and commercial development in Superior can accommodate the full mine-related housing demand (455 households), annual intergovernmental revenues from the State of Arizona would increase by about $380,000, relative to current conditions.

The Arizona State Land Department would also receive royalty payments from the proposed mine for a small area of ASLD lands that would be mined. The minimum ASLD royalty payment is 2 percent of the gross value of the minerals produced from their lands, but ASLD royalties average between 5 and 6 percent of the value (Arizona State Land Department 2019b). With ASLD owning the rights to approximately 2 percent of the overall copper resource, average annual royalty payments to ASLD over the life of the proposed mine are projected to be between $0.5 million and $1.5 million.

Mine-related demands and costs for public services. The Town of Superior anticipates that its costs of providing services related to public safety (police and fire protection) would increase by about 50 percent if and when the proposed mine becomes fully operational. Based on Superior's current expenditures to provide these services, this would represent an increase of about $375,000 per year in costs for the Town. The proposed mine would also use the wastewater services provided by the Town, but these services are provided on an enterprise basis (based on volumetric billing rates) and any effects on the cost of wastewater

Table 3.13.4-3. Projected effects of the project on Town of Superior general government costs

		Projected Conditions with Mine		Projected Mine Effect	
Metrics	Current Conditions	Near Term	Longer Term	Near Term	Longer Term
Resident population	2,999	3,389	4,182		
Employees*	707	2,527	2,527		
Employee weight†	0.33	0.33	0.33		
Effective service population	3,232	4,223	5,016	991	1,784
Expenditures/effective service population	$550	$550	$550		
General government costs‡ (millions, $)	$1.78	$2.32	$2.76	$0.54	$0.98

Sources: Minnesota IMPLAN Group Inc. (2016); Arizona Department of Transportation (2016); U.S. Census Bureau (2016)

* Employees based within ZIP code encompassing town of Superior.

† Approximate demand on Town services per local employee relative to a local resident.

‡ Excludes costs of self-funded enterprise funds such as wastewater services and ambulance services.

services should be offset by corresponding revenues. Construction and operations of the proposed mine could also affect the Town of Superior's costs to maintain its network of streets and roads, though this impact is more difficult to project (Jeavons 2018).

An alternative way to evaluate the effects of the proposed mine on the cost of providing services for the Town of Superior is based on the change in the effective population the Town would need to serve—including both new residents and the large number of in-commuting employees spending at least 8 hours per day in or adjacent to the town. On that basis, the total costs for Superior of providing general government services are projected to increase by about $540,000 per year in the near term and by about $980,000 per year in the longer term, as shown in table 3.13.4-3. This estimate reflects the additional demands the mine could place on street maintenance and general government activities for the Town. Overall, the proposed mine is projected to increase annual direct and indirect revenues for the Town of Superior by about $0.50 million in the near term, while adding about $0.54 million in annual costs for the Town. Longer term, if future development can accommodate the projected 455 new households in Superior resulting from mining activity, annual Superior revenues are projected to increase by about $1.08 million per year, while annual Superior costs are projected to increase by about $0.98 million per year (relative to current conditions). In addition, Resolution Copper has entered into an agreement with the Town of Superior to provide $1.65 million to support the Town's emergency response services over the period from 2016 to 2021, and other agreements to fund amenities and education.

Development and operations of the proposed mine would increase the demand for K–12 education services. However, schools in the Superior Unified School District are currently operating well below their designed capacity. Pinal County would also provide services to the proposed mine, including road maintenance, additional public safety services, and other county government activities. Based on projected changes in the

effective population served by Pinal County, the proposed mine could increase the costs of county service provision by about $3 million to $6 million per year. As shown in table 3.13.4-2, the proposed mine is projected to increase Pinal County's revenues by an annual average of between $12 million and $19 million, which is likely to substantially exceed the increase in the costs of service provision for the county.

Vulnerability to boom-bust cycles. Presuming that Resolution Copper's projections of operational employment, labor costs, non-labor operating costs, and output prove reasonably accurate, the proposed Resolution Copper Mine would have lower operating costs than the typical conventional copper mines in the region. It is unlikely that the proposed mine would have to suspend or substantially cut back its operations for purely economic reasons during either the 10-year ramp-up period or the following 20 years of full production. During the last 10 years of the mine's anticipated production life, the operational economics of the mine could be less advantageous, and there may be a greater likelihood that operations could be reduced or suspended for economic reasons.

Potential effects on the nature-based tourism economy. The proposed mine would have operations located east and west of the town of Superior. The tailings produced by the proposed mine would be stored at one of four sites currently being considered as alternatives. The activities at each of the proposed sites would affect the region's nature-based tourism economy, which includes the economic activity of both local and non-local users of the area's natural amenities for tourism and recreation. Nature-based tourists may participate in one or more activities, including OHV use, camping, hiking, rock climbing, hunting, fishing, and picnicking.

Most of the effects would occur in the town of Superior and Pinal and Gila Counties. The proposed mine and its associated facilities would be distributed across a large amount of land in Pinal and Gila Counties, where nature-based tourism is the primary tourism activity. As a result, the proposed mine's effects on nature-based tourism would vary by location and activity. AGFD projects that the tailings storage facilities would reduce wildlife-related recreation expenditures during the potential 60-year period[71] of construction, operations, and closure/reclamation of the proposed mine (Arizona Game and Fish Department 2018e). As shown in table 3.13.4-4, the magnitude of the effect varies by the location of the tailings storage facility. Other impacts are summarized in the following sections: transportation and access (see section 3.5), scenic resources (see section 3.11), noise and vibration (see section 3.4), and air quality (see section 3.6). Many of the potential economic effects on nature-based tourism are not quantified because of a lack of visitation data but are discussed in qualitative terms in the following text. If the proposed mine causes visitation and spending patterns to shift, it may result in lower tourism spending receipts for local businesses, which in turn could reduce tourism-related earnings and employment in the analysis area.

Table 3.13.4-4. Total projected reduction in direct wildlife-related recreation expenditures under each tailings alternative

Tailing Alternatives	Projected Annual Reduction in Visitor Spending ($)	Projected Reduction in Visitor Spending over 60-year Period ($)
Alternative 2 – Near West Proposed Action	66,920	4.0 million
Alternative 3 – Near West – Ultrathickened	66,920	4.0 million
Alternative 4 – Silver King	60,368	3.6 million
Alternative 5 – Peg Leg	12,254	735,269
Alternative 6 – Skunk Camp	70,554	4,200,000

Source: AGFD (2018e)

71. The impacts disclosed in this section are based in part on an analysis conducted by the AGFD (a cooperating agency on the project) and provided to the Tonto National Forest. In that analysis, the AGFD used a mine life span of 60 years, which differs slightly from the mine life described in chapter 2 of 51 to 56 years.

East Plant Site. The operations at the East Plant Site would affect some of the natural amenities that attract tourists to the area. The East Plant Site is located on approximately 1,544 acres of land managed by the Forest Service, including 1,500 acres of land that would subside, ending the use of the area by the general public. The East Plant Site and subsidence area would affect the Oak Flat Campground, an area that is popular with campers, picnickers, hikers, and rock climbers. OHV activities would also be affected by the proposed mine's operations. Portions of NFS Road 315, a popular off-road loop between U.S. 60 and SR 177, would be eliminated by the activities at the East Plant Site and the eventual subsidence of the area. In total, AGFD estimates that about 6 miles of public access motorized routes would be lost in addition to 421 acres of dispersed camping. The loss of this area would have potentially large effects on nature-based tourism patterns around the town of Superior. The impact on the site could result in a loss of tourism spending in and around the town, depending on the location of substitute sites. The site is also used for hunting, although according to AGFD the area does not contain a disproportionate amount of habitat favoring any particular species of interest to hunters. In total, AGFD estimated that the effects of the proposed mine at the East Plant Site would result in 188 fewer hunter days per year. This would lead to a direct reduction of $10,510 annual wildlife-related recreation spending in the local economy, which would equal a nominal value of $630,480 over the 60-year life of the proposed mine (Arizona Game and Fish Department 2018e).

West Plant Site. The West Plant Site is located on private land near the town of Superior's northwest edge. The West Plant Site was formerly used by the Magma Mine as the site of its copper concentrator. The proposed mine would increase the scale of industrial activity at the site, but the proposed activities would be consistent with the site's historical use. The increased industrial activity could create beneficial effects on the town's tourism economy for tourists interested in mining activity.

Alternatives 2 and 3 – Near West. The area on and around the Near West tailings alternative is used for a variety of activities, including OHV use, camping, and hunting, by visitors from outside Pinal County. AGFD estimates that the Near West tailings alternative would affect about 23 miles of motorized off-road trails and eliminate 1,737 acres of dispersed camping (Arizona Game and Fish Department 2018e). This would lead to more crowding and congested conditions with the potential to increase competition and conflict between activities. This could negatively impact the number of nature-based tourist visits and tourism spending, resulting in lower tourism spending, earnings, and employment.

The area is popular with hunters due to its populations of mule deer, white-tailed deer, javelina, quail, dove, and coyotes and other predators. According to a survey and mapping exercise conducted by AGFD, the site has some of the highest rates of use amongst hunters. The Near West tailings alternative would reduce the number of hunting days on the site by approximately 1,200 hunter-days per year, amounting to a reduction in direct expenditures of $66,920 per year, or $4.0 million over the 60-year operational time horizon of the proposed mine (Arizona Game and Fish Department 2018e).

Alternative 4 – Silver King. The alternative would affect the aesthetics of the area, particularly for users of OHV routes and other tourists who value the views and vistas of the Superstition Mountains. The aesthetic effects could change people's desire to visit and recreate in the area, thereby shifting visitation and spending patterns and potentially reducing nature-based tourism expenditures in the region. In total, AGFD estimates that there are about 20 miles of public access motorized routes and 1,434 acres of dispersed camping that would be affected. The site at the proposed Silver King alternative receives a moderate to high number of hunters who use the area to hunt mule deer and predatory animals. The higher elevation areas of the site are the most valued by hunters because the quality of mule deer habitat increases with altitude at the site. According to AGFD, the proposed alternative would have a negative effect on mule deer populations, which would reduce the number of hunting days by about 1,078 per year. This would reduce the amount of direct expenditures of hunters by about $60,368 per year, or $3.6 million over the 60-year operational time horizon of the proposed mine (Arizona Game and Fish Department 2018e).

Alternative 5 – Peg Leg. Development of this alternative would have a negative effect on the aesthetics of the area, particularly for visitors driving from the Florence-Kelvin Highway and for outdoor enthusiasts who value pristine view of the Mineral Mountains and the Gila River. AGFD estimates that there are about 45 mile of public access motorized routes and 1,009 acres of disperse camping within the tailings footprint (excluding pipeline corridors). The Peg Leg alternative site also contains a variety of species that are popular with hunters, including predators and small game. This also makes the site popular with wildlife-watchers. The AGFD estimates that the site supports about 219 hunting-days each year. Under this alternative, the hunting activity would be lost, resulting in a loss of direct economic activity amounting to $12,254 per year, or $735,269 over the 60-year life of the proposed mine (Arizona Game and Fish Department 2018e).

Alternative 6 – Skunk Camp. This alternative would have the largest negative effect on tourism and recreation of any of the proposed alternatives. AGFD estimates that there are about 32 miles of public access motorized routes and 861 acres of dispersed camping within the tailings footprint (excluding pipeline corridors). Hunting is permitted on State Trust lands within the proposed location of the Skunk Camp alternative, and the site is also popular with people who enjoy watching wildlife. Private lands at the site may or may not be open to public access at the discretion of the landowner. The area is characterized as excellent mule deer, javelina, and Gambel's quail habitat, and transitional white-tailed deer habitat. This area is one of three major areas most frequently hunted in this Game Management Unit and hunters tend to concentrate within these few areas to camp and stage for travel to nearby hunting destinations. Key to recreation in this area is access via Dripping Springs Road. According to a survey and mapping exercise conducted by AGFD, the Skunk Camp alternative would reduce the number of hunting days on the site by approximately 1,269 hunter-days per year, amounting to a reduction in direct expenditures of $70,554 per year, or $4.2 million over the 60-year operational time horizon of the proposed mine (Arizona Game and Fish Department 2018e).

Potential property value effects. While the proposed mine facilities at the East Plant Site and the West Plant Site could have some adverse effects on property values in Superior due to creating a more industrialized setting, those effects would likely be more than offset by the increased demand for housing and commercial space in the town. The primary adverse effects on property values from the proposed mine would likely be associated with the tailings storage facilities.

The proposed mine would likely affect residential property values within at least a 5-mile radius of the proposed location of the tailings facilities under each alternative. Table 3.13.4-5 summarizes the proposed mine's estimated effects on residential property values based on current development near the proposed locations of the mine tailings under each alternative and the current value of those properties. Estimates in

Table 3.13.4-5. Total projected property value reduction under each tailings alternative

Tailing Alternatives	Number of Residential Parcels within 5 Miles of Tailings Perimeter	Total Projected Property Value Reduction ($)	Change in Value (%)
Alternative 2 – Near West Proposed Action	1,370	3,059,395	−4.1
Alternative 3 – Near West – Ultrathickened	1,370	3,059,395	−4.1
Alternative 4 – Silver King	1,181	5,472,374	−10.6
Alternative 5 – Peg Leg	8	69,178	−6.3
Alternative 6 – Skunk Camp	31	57,575	−4.0

Sources: Pinal County Assessor's Office (2017); Gila County Assessor's Office (2017); BBC Research and Consulting (2018)

Note: GIS data for residential parcel data were obtained from standard Pinal County and Gila County coverages.

table 3.13.4-5 indicate the magnitude of potential property value effects but are based on a limited body of directly relevant research. For some alternatives, it is possible that Resolution Copper may purchase some residential parcels; this possibility was not incorporated into the figures shown later in this section.

3.13.4.3 Cumulative Effects

The Tonto National Forest identified the following reasonably foreseeable future actions as likely, in conjunction with development of the Resolution Copper Mine, to contribute to cumulative changes to socioeconomic conditions in the Town of Superior and in other nearby communities, particularly those in northern Pinal County, southwestern Gila County, and eastern Maricopa County. As noted in section 3.1, past and present actions are assessed as part of the affected environment; this section analyzes the effects of any RFFAs, to be considered cumulatively along with the affected environment and Resolution Copper Project effects.

- **Pinto Valley Mine Expansion.** The Pinto Valley Mine is an existing open-pit copper and molybdenum mine located approximately 8 miles west of Miami, Arizona, in Gila County. Pinto Valley Mining Corporation is proposing to expand mining activities onto the Tonto National Forest and extend the life of the mine to 2039.
- **Florence Copper In-Situ Mining Project.** This mining project, located on the northwestern outskirts of the town of Florence, is an underground copper leaching, recovery, and processing operation that is now in a production testing phase. The operational life of the mine is estimated at approximately 20 years. The mine owner, Florence Copper, estimates the operation would create and support an annual average of 796 direct and indirect jobs in Arizona, with approximately 480 of those jobs in Pinal County.
- **Ray Land Exchange and Proposed Plan Amendment.** ASARCO is also seeking to complete a land exchange with the BLM by which the mining company would gain title to approximately 10,976 acres of public lands and federally owned mineral estate located near ASARCO's Ray Mine in exchange for transferring to the BLM approximately 7,304 acres of private lands, primarily in northwestern Arizona. It is known that at some point ASARCO wishes to develop a mining operation in the "Copper Butte" area west of the Ray Mine; however, no details are currently available as to potential future employment numbers or mineral production rates at this possible future facility.
- **Tonto National Forest Travel Management Plan.** The Tonto National Forest is currently in the process of developing a Supplemental EIS to address certain court-identified deficiencies in its 2016 Final Travel Management Rule EIS. This document and its implementing decisions are expected within the next 2 years. This document is likely to have substantial impacts on current recreational uses of Tonto National Forest lands and transportation routes, which in turn would have socioeconomic ramifications with local recreation spending, road maintenance, or displacement of recreation to other locations.
    - More specifically, the Supplemental EIS proposes a total of 3,708 miles of motorized routes open to the public, a reduction from the 4,959 miles of motorized open routes prior to the Travel Management Rule. Limiting availability of motorized routes open to the public would result in reduced access to recreational activities currently practiced on the Tonto National Forest, including sightseeing, camping, hiking, hunting, fishing, recreational riding, and collecting fuelwood and other forest products. The proposed action would designate 2,341 miles of motorized trails. Currently, there are no designated motorized trails on the Tonto National Forest.

Other public infrastructure development and commercial economic activity is likely to occur in this area of south-central Arizona during

the foreseeable future life of the Resolution Copper Mine (50–55 years), including developments that have yet to be imagined or planned. In aggregate, these foreseeable and as-yet unknown actions would contribute to general socioeconomic conditions in the region in both positive and potentially negative terms. Large-scale mining development, in particular, tends to infuse relatively quick economic stimulus to local economies but can also create pressures on local infrastructure such as roads, schools, medical services, and the availability and affordability of housing. Large-scale mining projects such as the Resolution Copper Mine and the mining developments described here may also adversely affect tourism, recreational opportunities, and what are considered desirable but less-tangible qualities of a rural setting and lifestyle.

3.13.4.4 Mitigation Effectiveness

The Forest Service is in the process of developing a robust mitigation plan to avoid, minimize, rectify, reduce, or compensate for resource impacts that have been identified during the process of preparing this EIS. Appendix J contains descriptions of mitigation concepts being considered and known to be effective, as of publication of the DEIS. Appendix J also contains descriptions of monitoring that would be needed to identify potential impacts and mitigation effectiveness. As noted in chapter 2 (section 2.3), the full suite of mitigation would be contained in the FEIS, required by the ROD, and ultimately included in the final GPO approved by the Forest Service. Public comment on the EIS, and in particular appendix J, will inform the final suite of mitigations.

At this time, no mitigation measures have been identified that would be pertinent to socioeconomics. Applicant-committed environmental protection measures have already been detailed elsewhere in this section, will be a requirement for the project, and have already been incorporated into the analysis of impacts.

Unavoidable Adverse Impacts

Loss of jobs in the local tourism and outdoor recreation industries cannot be avoided or fully mitigated. Likewise, loss in property values for property close to the mine would constitute an impact that cannot be avoided or fully mitigated. The applicant-committed measures would be effective at expanding the economic base of the community and improving resident quality of life, and could partially offset the expected impacts, although many of the current agreements would expire prior to full construction of the mine.

3.13.4.5 Other Required Disclosures

Short-Term Uses and Long-Term Productivity

Socioeconomic impacts are both positive and negative and are primarily short term. The project would provide increased jobs and tax revenue from construction through final reclamation and closure. However, this would be offset by potential impacts on local tourism and outdoor recreation economies, and a decrease in nearby property values; as these effects are largely the result of the tailings storage facility, which is a permanent addition to the landscape, they could persist over the long term.

The long-term continued population and economic growth in areas of the Copper Triangle with existing copper mines indicates that these impacts are in the magnitude of being decades long and would not be permanent.

Irreversible and Irretrievable Commitment of Resources

Some changes in the nature of the surrounding natural setting and landscape would be permanent, including the tailings storage facility and the subsidence area. The action alternatives would therefore potentially cause irreversible impacts on the affected area with regard to changes in the local landscape, community values, and quality of life.

Overview

In accordance with long-established agency practice and the requirements of the NHPA, the Tonto National Forest regularly conducts government-to-government consultation with tribes in Arizona and elsewhere in the Southwest that may be affected by Federal decision-making. The Resolution Copper Project and Land Exchange has a very high potential to directly, adversely, and permanently affect numerous cultural artifacts, sacred seeps and springs, traditional ceremonial areas, resource-gathering localities, burial locations, and other places and experiences of high spiritual and other value to tribal members. This section describes the interactions to date between the Tonto National Forest and the 11 Indian Tribes actively participating in consultation related to the project.

3.14 Tribal Values and Concerns

3.14.1 Introduction

This project is located in an area that is important to many tribes and has been for many generations, and continues to be used for cultural and spiritual purposes. Tonto National Forest has consulted regularly with 11 federally recognized tribes that are culturally affiliated with the lands that would be affected and have had the opportunity to be active in the consultation, review, and comment processes of the project. No tribe supports the desecration/destruction of ancestral sites. Places where ancestors have lived are considered alive and sacred. It is a tribal cultural imperative that these places should not be disturbed or destroyed for resource extraction or for financial gain. Continued access to the land and all its resources is necessary and should be accommodated for present and future generations. Participation in the design of this destructive activity has caused considerable emotional stress and brings direct harm to a tribe's traditional way of life; however, it is still deemed necessary to ensure that ancestral homes and ancestors receive the most thoughtful and respectful treatment possible.

By law, Federal agencies must consult with Indian Tribes about proposed actions that may affect lands and resources important to them, in order to comply with the NHPA for NRHP-listed historic properties (see Section 3.14.3, Affected Environment, for the list of laws and regulations). Section 3003 of the NDAA also requires that the Secretary of Agriculture engage in government-to-government consultation with affected tribes concerning issues related to the land exchange. The Secretary of Agriculture mandated that Tonto National Forest consult with Resolution Copper to seek mutually acceptable measures to address the concerns of the affected tribes and minimize the adverse effects from mining and related activities on the conveyed lands.

Beginning in 2015, the Tonto National Forest began consultation with 11 tribes regarding the proposed mine, the land exchange, and the development of alternate tailings locations to identify issues of tribal concern and possible measures to mitigate the adverse effects on tribal issues. Tonto National Forest also consulted the tribes regarding the management plan for the Apache Leap SMA, as required by Section 3003 of the NDAA.

Government-to-government consultations are ongoing between Tonto National Forest and the Fort McDowell Yavapai Nation, Gila River Indian Community, Hopi Tribe, Mescalero Apache Tribe, Pueblo of Zuni, Salt River Pima-Maricopa Indian Community, San Carlos Apache Tribe, Tonto Apache Tribe, White Mountain Apache Tribe, Yavapai-Apache Nation, and Yavapai-Prescott Indian Tribe. The four O'odham tribes (the Four Southern Tribes Cultural Committee) have delegated consultation with the Tonto National Forest to the Salt River Pima-Maricopa Indian Community and to the Gila River Indian Community. The BLM has also identified four tribes that may be affected if the alternative on BLM land is affected: the Ak-Chin Indian Community, Fort Sill Apache Tribe, Pascua Yaqui Tribe, and Tohono O'odham Nation. See Chapter 4, Consulted Parties, for a full account of consultation to date.

Tribal values and concerns regarding the land exchange and the proposed GPO include resources with traditional or cultural significance, some of which are also described in Section 3.12 Cultural Resources. Resources of traditional or cultural significance can be traditional cultural properties (TCPs) as defined by National Register Bulletin 38, “Guidelines for Documenting and Evaluating Traditional Cultural Properties” (Parker and King 1998), sacred places, holy places, and traditional ecological knowledge places (TEKPs)—including burial locations, landforms, viewsheds, and named locations in the cultural landscape; water sources; and traditional resource-gathering locations for food, materials, minerals, and medicinals.

3.14.2 Analysis Methodology, Assumptions, and Uncertain and Unknown Information

3.14.2.1 Analysis Area

The direct, indirect, and atmospheric analysis areas for tribal values and concerns are the same as for cultural resources, found in section 3.12.2. The direct analysis area for the proposed project is defined by several factors: the acreage of ground disturbance expected for each mine component described in the GPO and the acreage of land leaving Federal stewardship as a result of the land exchange. The direct analysis area for the proposed action (GPO and land exchange) is approximately 40,988 acres and consists of the following, which includes access roads and other linear infrastructure:

- East Plant Site and subsidence area, including the reroute of Magma Mine Road (1,539 acres of which is within the Oak Flat Federal Parcel), which is NFS and ASLD lands;
- 2,422-acre Oak Flat Federal Parcel, which is NFS land to be exchanged with Resolution Copper;
- 940-acre West Plant Site;
- 6.96-mile Silver King to Oak Flat transmission line;
- 169-acre MARRCO railroad corridor and adjacent project components;
- 553-acre filter plant and loadout facility; and
- Alternatives 2–6 tailings storage facilities and tailings corridors: tailings storage facility and tailings corridor for Alternatives 2 and 3; and Alternative 4 – Silver King, Alternative 5 – Peg Leg, and Alternative 6 – Skunk Camp, which have different locations and overall footprints from the GPO tailings storage facility and tailings corridor.

The indirect analysis area consists of a 2-mile buffer around all project and alternative components and contains approximately 320,693 acres. The 2-mile buffer is designed to account for impacts on resources not directly tied to ground disturbance and outside the direct analysis area.

The atmospheric analysis area consists of a 6-mile buffer around all project and alternative components. This distance is consistent with the indirect analysis area for visual impacts in section 3.11, which is based on BLM visual guidance and Forest Service guidance, modified by the addition of a small portion of land south of Picketpost Mountain, the extension another 1 mile farther east to the San Carlos Apache Indian Reservation boundary, and the extension to the southeast to encompass Kearny and historical use of that area. The indirect impacts analysis area encompasses approximately 750,229 acres. The analysis area for tribal values is shown in figure 3.14.2-1.

3.14.2.2 Analysis Approach

The Forest Service and NEPA team worked collaboratively with the tribes to gather information on tribal values and resources via an ethnographic study (Hopkins et al. 2015) and through ongoing consultation. Resolution Copper collected cultural resources information important to tribal members through Class I records searches and Class III pedestrian surveys. Tribal monitors also surveyed to specifically look for TEKPs and other tribal resources that archaeologists might not otherwise have recognized.

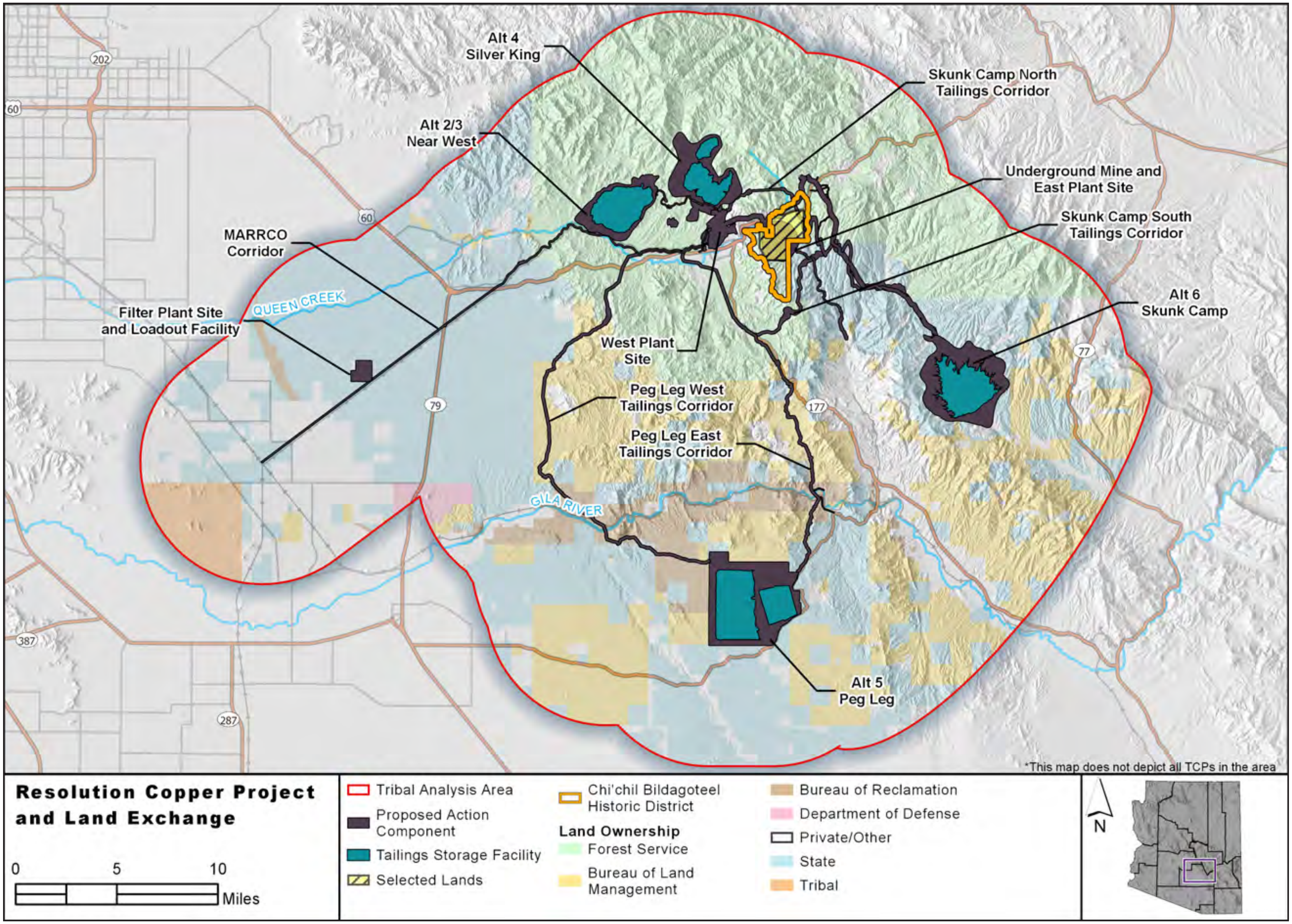


Figure 3.14.2-1. Tribal resources analysis area

Survey of Alternative 5 – Peg Leg pipeline routes and some small areas of other project components that have moved as a result of design changes will occur in 2019, and the results will be updated in the FEIS.

Impact Indicators

Direct impacts on resources of traditional cultural significance (archaeological sites; burial locations; spiritual areas, landforms, viewsheds, and named locations in the cultural landscape; water sources; food, materials, mineral, and medicinal plant gathering localities; or other significant traditionally important places) would consist of damage, loss, or disturbance that would alter the characteristic(s) that make the resource eligible for listing in the NRHP or sacred to the respective cultural group(s). The loss might be caused by ground disturbance, loss of groundwater or surface water, or by the erection of facilities that alter the viewshed. Indirect impacts would consist primarily of visual impacts from alterations to setting and feeling, auditory impacts, or inadvertent disturbance.

Impact indicators for this analysis include the following:

- Loss, damage, or disturbance to historic properties, including TCPs listed in or eligible for listing in State or Federal registers, that are significant to Native American tribes.
- Loss, damage, or disturbance to burial sites; spiritual areas and viewsheds; cultural landscapes; sacred places; springs and other water resources; food and medicinal plants; minerals; and hunting, fishing, and gathering areas.
- Loss of access to burial sites; spiritual areas and viewsheds; cultural landscapes; sacred places; springs and other water resources; food and medicinal plants; minerals; and hunting, fishing, and gathering areas.
- Alterations to setting, feeling, or association of historic properties significant to Native American tribes, including TCPs where those characteristics are important to their State or Federal register eligibility.

If the land exchange occurs, as mandated by Congress in the Southeast Arizona Land Exchange, the selected lands would be conveyed to Resolution Copper no later than 60 days after the publication of the FEIS, and the Oak Flat Federal Parcel would become private property and no longer be subject to the NHPA. Under Section 106 of the NHPA and its implementing regulations (38 CFR 800), historic properties leaving Federal management is considered an adverse effect regardless of the plans for the land, meaning that as analyzed under NEPA, the land exchange would have an adverse impact on resources significant to the tribes.

Adverse impacts on historic properties would be avoided, minimized, or mitigated through the Section 106 process of the NHPA and through Tonto National Forest's consultations with Resolution Copper in accordance with Section 3003 of the NDAA. Adverse impacts on resources that may not be historic properties under Section 106 would be avoided, minimized, or mitigated through steps outlined in the FEIS and ROD.

3.14.3 Affected Environment

The primary legal authorities and agency guidance relevant to this analysis of anticipated project-related impacts on tribal resources are shown in the accompanying text box.

A complete listing and brief description of the regulations, reference documents, and agency guidance used in this effects analysis may be reviewed in Newell (2018i).

3.14.3.1 Existing Conditions and Ongoing Trends

Resolution Copper surveyed each of the areas comprising the proposed mine for NRHP-eligible historic properties, as outlined in section 3.12. Tribal monitors resurveyed or accompanied archaeological survey crews in those areas to identify TEKPs of importance to the four cultural groups with ties to the area (Puebloan, O'odham, Apache, and Yavapai), to include springs and seeps, plant and mineral resource collecting areas, landscapes and landmarks, caches of regalia and human remains, and sites that may not have been recognized by non-Native archaeologists. All springs and seeps are considered sacred by all of the consulting tribes.

Tonto National Forest conducted tribal monitor training sessions in January and October, as described in Section 4.7.1, Tribal Monitor Program. Tribal monitors were added to the contracted archaeological crews to survey the selected lands and all tailings alternatives; these surveys are anticipated to be complete by fall 2019. During the surveys, tribal monitors are identifying potential TEKPs and special interest areas or resources such as natural resources special interest areas, landforms, landscapes, and springs, as well as plants, animals, and minerals of special interest.

As a result of the tribal monitoring program, a draft Tribal Monitor report has been completed for Alternative 5 – Peg Leg. Draft Tribal Monitor reports on the Oak Flat Federal Parcel, Near West (Alternatives 2 and 3), Silver King (Alternative 4), and Skunk Camp (Alternative 6) are expected in the fall of 2019 and will be used for the FEIS analysis. In 2015, the Tonto National Forest, in partnership with the San Carlos Apache Tribe, composed a nomination for Oak Flat, the area originally known as *Chí'chil Biłdagoteel*, to be listed on the National Register of Historic Properties as a TCP (Nez 2016). This effort consisted of extensive literature research and interviews with tribal members.

Principal Regulations, Policies, and Guidelines Used in the Effects Analysis for Tribal Values and Concerns

- National Historic Preservation Act of 1966 (54 U.S.C. 300101 et seq.)
- Archaeological Resources Protection Act (16 U.S.C. 470aa-470mm)
- American Indian Religious Freedom Act (AIRFA) of 1978 (42 U.S.C. 1996)
- Religious Freedom Restoration Act (42 U.S.C. 2000bb et seq.)
- Native American Graves Protection and Repatriation Act (NAGPRA) of 1990 (25 U.S.C. 3001–3013)
- Executive Order 12898 (February 16, 1994), "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations"
- Executive Order 13007 (May 24, 1996), "Indian Sacred Sites"
- Executive Order 13175 (November 6, 2000), "Consultation and Coordination with Indian Tribal Governments"
- Bald and Golden Eagle Protection Act of 1940 (16 U.S.C. 688–688d)
- Endangered Species Act (16 U.S.C. 1531-1543)
- Migratory Bird Treaty Act (16 U.S.C. 703-711)
- National Environmental Policy Act (42 U.S.C. 4321 et seq.)

In addition, an ethnographic study was completed titled "Ethnographic and Ethnohistoric Study of the Superior Area, Arizona" (Hopkins et al. 2015). The study consisted of archival and existing literature review and compilation, as well as oral interviews and field visits with tribal members to collect oral history and knowledge. Tribal members accompanied research staff to important places throughout the study area and shared information about those places. Members of the San Carlos Apache Tribe, Tonto Apache Tribe, White Mountain Apache Tribe, Yavapai-Apache Nation, Fort McDowell Yavapai Nation, Yavapai-Prescott Indian Tribe, Gila River Indian Tribe, Salt River Pima-Maricopa Indian Community, Hopi Tribe, and Pueblo of Zuni contributed to the study.

Direct Analysis Area

ARCHAEOLOGICAL SITES

In section 3.12, we discuss the 721 archaeological sites recorded to date in the direct analysis area. Twenty-five of those sites have components attributed to Apache/Yavapai peoples; 696 are attributed to Hohokam or Hohokam/Salado. The remaining sites or components are attributed to Archaic, Salado, Euro-American, or Mexican-American peoples.

TRADITIONAL CULTURAL PROPERTIES AND CULTURAL LANDSCAPES

A portion of the direct analysis area is within the *Chí'chil Biłdagoteel* Historic District, which is listed on the NRHP as an Apache TCP. Apache Leap, Oak Flat, and 38 archaeological sites that contribute to the eligibility of the district are within the *Chí'chil Biłdagoteel* Historic District. Apache Leap is within the indirect analysis area, but access to the Protohistoric/Historic Apache village at its summit is through the direct analysis area.

As required by the land exchange, the Tonto National Forest set aside Apache Leap, a sacred landscape for the Apache and Yavapai, as a special management area totaling 839 acres (Apache Leap SMA). The Tonto National Forest was also directed in the NDAA to develop a management plan in consultation with the tribes. Meetings were held individually with tribes, with cultural groups, and an all-tribes meeting to discuss the management options for this sacred landscape. Tribes made the following requests regarding the Apache Leap SMA:

1. Leave it in its natural state;
2. Guarantee access, including possibly developing a new road, so that tribal members can reach the top to perform ceremonies once the current access route is closed due to subsidence;
3. Do not renew or reissue the extant grazing permits; and
4. Permit day-use only (no overnight camping), and do not permit any rock-climbing.

These requests were incorporated into the management plan as part of the environmental assessment of the SMA; a final decision notice, special area management plan, and corresponding forest plan amendment was issued December 26, 2017. When the new access route is designed, it will require an environmental assessment to determine whether the route poses any adverse effects on cultural and/or tribal resources.

Additional resources (TEKPs and special interest areas or resources) were recorded during the ethnographic study within the analysis areas (Hopkins et al. 2015) and by the tribal monitor survey conducted in 2018. These include a petroglyph panel near one of the springs; the Emory oak grove at Oak Flat, which has also been used as a ceremonial grounds by San Carlos Apache; a rock ring and several spring areas; ancestral settlement; and a beargrass resources area.

SPRINGS

A number of springs are located within the direct analysis area that could be directly disturbed or impacted by dewatering (see section 3.7.1). Springs are sacred to all the consulting tribes.

NATURAL RESOURCES AREA

A number of natural resources special interest areas are located within the direct analysis area: a rock formation, a dry spring, and three vantage points.

PLANT AND MINERAL RESOURCES

Forty-nine types of plants of special interest have been identified to date within the direct impacts analysis area and include the following: banana yucca (*Yucca baccata*), beargrass (*Nolina microcarpa*), buffalo gourd (*Cucurbita foetidissima*), fairyduster (*Calliandra eriophylla*), soaptree yucca (*Yucca elata*), queen of the night (Peniocereus greggii), ragweed (*Ambrosia ambrosioides*), thistle (*Cardus nutans*), and wild spinach (*Chenopodium* sp.).

Eight minerals or types of minerals important to tribal groups were identified in the direct impacts analysis area: Apache tear obsidian, caliche, mica, red ore, a polishing stone, several quartz crystals, an iron sand deposit, and schist.

Indirect Analysis Area

A portion of the *Chí'chil Biłdagoteel* Historic District TCP is within the indirect analysis area outside of the direct analysis area. Specifically, Apache Leap to the west of Oak Flat is adjacent to the direct analysis area.

Atmospheric Analysis Area

Tonto National Forest's consultations and ethnohistoric study of the general area around Oak Flat have identified many named Western Apache locations and TEKPs, as well as Yavapai band traditional territories. This applies particularly to the areas within the U.S. 60 corridor—for example, the Superstition Mountains, Picketpost Mountain, Apache Leap, and Devil's Canyon are all named sacred locations. A portion of the *Chí'chil Biłdagoteel* Historic District is within the atmospheric analysis area. At least four springs and the Queen Creek watershed, which are sacred to all the tribes, are located within the indirect analysis area. The atmospheric analysis area also contains prehistoric sites and resources of interest to the tribes that are related to the prehistoric occupation of the area—the Gila River Indian Community, the Hopi Tribe, the Salt River Pima-Maricopa Indian Community, and the Pueblo of Zuni.

3.14.4 Environmental Consequences of Implementation of the Proposed Mine Plan and Alternatives

3.14.4.1 Alternative 1 – No Action

Direct Impacts

Under the no action alternative, the Forest Service would not approve the GPO, current management plans would remain except for the development of a new Tonto National Forest forest plan, and Resolution Copper would continue current activities on private property. As described in section 2.2.3, the no action alternative analysis analyzed the impacts of (1) the Forest Service's not approving the GPO, and (2) the land exchange's not occurring.

If the Forest Service does not approve the GPO, the mining operation would not occur; if the land exchange does not occur, the selected lands would remain under Forest Service management. Under either scenario, no direct impacts are anticipated to archaeological sites, TCPs, springs, or other resources significant to the tribes, including loss of access to resources.

Indirect and Atmospheric Impacts

If either the land exchange does not occur or the GPO is not approved, no adverse indirect or atmospheric impacts are anticipated to resources other than to some springs. With or without the land exchange, the continued dewatering of mine shafts on private land would occur,

lowering the water table in the area, which may have adverse indirect impacts on six springs. See section 3.7.1 for more information on dewatering and its potential effects on area resources.

3.14.4.2 Impacts Common to All Action Alternatives

The impacts on the Oak Flat Federal Parcel are common to all action alternatives. The Oak Flat Federal Parcel contains 31 NRHP-eligible historic properties and one NRHP-listed TCP, which is near an Emory oak stand that Apache and Yavapai use to harvest acorn. Because the Tribal Monitor report is not complete at this time, the total number and type of impacted resources on Oak Flat is unknown. All of these resources would be adversely impacted by leaving Federal management. In particular, the loss of the ceremonial area and acorn-collecting area in Oak Flat and/or the loss of access to them would be a substantial threat to the perpetuation of cultural traditions of the Apache and Yavapai tribes, because healthy groves are few and access is usually restricted unless the grove is on Federal land. Several springs located on the Oak Flat Federal Parcel would be lost due to the development of the subsidence area.

Effects of the Land Exchange

If the land exchange occurs, as mandated by Congress in the Southeast Arizona Land Exchange, the selected lands would be conveyed to Resolution Copper no later than 60 days after the publication of the FEIS, and the Oak Flat Federal Parcel would become private property and no longer be subject to the NHPA. Under Section 106 of the NHPA and its implementing regulations (38 CFR 800), historic properties leaving Federal management is considered an adverse effect regardless of the plans for the land, meaning that as analyzed under NEPA, the land exchange would have an adverse effect on resources significant to the tribes.

The Oak Flat Federal Parcel contains 31 NRHP-eligible historic properties, one NRHP-listed TCP, and the only developed campground on the Tonto National Forest, which is near an Emory oak stand that Apache and Yavapai use to harvest acorn. All of these resources would be adversely affected by leaving Federal management. In particular, the loss of the ceremonial area and acorn-collecting area in Oak Flat would be a substantial threat to the perpetuation of cultural traditions of the Apache and Yavapai tribes, because healthy groves are few and access is usually restricted unless the grove is on Federal land.

Effects of Forest Plan Amendment

The Tonto National Forest Land and Resource Management Plan (1985b) provides guidance for management of lands and activities within the Tonto National Forest. It accomplishes this by establishing a mission, goals, objectives, and standards and guidelines. Missions, goals, and objectives are applicable on a forest-wide basis. Standards and guidelines are either applicable on a forest-wide basis or by specific management area.

A review of all components of the 1985 Forest Plan was conducted to identify the need for amendment due to the effects of the project, including both the land exchange and the proposed mine plan (Shin 2019). A number of standards and guidelines (10) were identified applicable to management of tribal resources. None of these standards and guidelines were found to require amendment to the proposed project, on either a forest-wide or management area-specific basis. For additional details on specific rationale, see Shin (2019). No standards and guidelines were identified that are strictly applicable to tribal resources; however, a great number of standards and guidelines are related to resources considered important or sacred by tribes, including wildlife, water resources, and scenic resources. The need for a forest plan amendment for these resources is discussed in the appropriate section.

Summary of Applicant-Committed Environmental Protection Measures

A number of environmental protection measures are incorporated into the design of the project that would act to reduce potential impacts on resources of tribal value and concern. These are non-discretionary measures and their effects are accounted for in the analysis of environmental consequences.

Applicant-committed environmental protection measures by Resolution Copper to reduce impacts on tribal resources are covered in detail in the Programmatic Agreement (see appendix O) and in the ROD. Specifically, Resolution Copper

- is sponsoring a tribal monitoring program to identify resources of interest to tribal groups as described in Section 4.7.1, Tribal Monitor Program;
- is currently working with tribal representatives on Emory oak restoration studies as described in Section 4.7.2, Emory Oak Restoration;
- would develop a TCP Redress Plan, which would include the tribal monitoring program and Emory oak restoration, as well as other measures to be taken to reduce impacts on resources; and
- would develop a monitoring and treatment plan of inadvertent discoveries of cultural resources significant to tribal groups. If previously unidentified cultural resources are discovered during construction activities on Tonto National Forest, work would cease within 100 feet of the location, and the Forest Service would be contacted for instruction before work would continue at that location.

3.14.4.3 Alternatives 2 and 3 – Near West

Direct Impacts

Under Alternatives 2 and 3, the land exchange would occur and the Forest Service would approve the GPO. For both alternatives, there are variations of the footprint and the type of storage facility proposed in the modified GPO location; however, the direct effects would be the same for both. Section 3.12.4.2 contains a description of the location of the 132 prehistoric and historic archaeological sites (31 of which have eligibility yet to be determined) that would be impacted by these alternatives and their associated mine operation areas (East Plant Site, subsidence area, West Plant Site, tailings facility and corridor, Silver King Mine Road, MARRCO corridor, and roads) (see table 3.12.4-1).

One large TEKP was recorded for the tailings facility and corridor proposed for Alternatives 2 and 3; it incorporates the active springs and a currently unknown number of historic properties that have been identified by the tribes as interconnected. Please note that the Tribal Monitor report for the Near West tailings area is pending, so all impacts are not known at this time. The area also contains many plants and minerals of use to tribes. All alluvial deposits would be removed to expose bedrock for the tailings storage facility, so all of these soil and vegetation resources would be destroyed by construction and use of the facility. Resources in the direct analysis area may be lost completely because of ground disturbance, or tribes may lose access to those resource once they are part of the mine.

Either tailings storage facility configuration would adversely reduce and affect the flow of water into Queen Creek; the long-term effects on groundwater quality due to tailings seepage are discussed in section 3.7.2.

Indirect Impacts

For both alternatives, a portion of the *Chí'chil Biłdagoteel* Historic District TCP may be indirectly impacted from inadvertent damage from construction activities or increased non-tourism visitation to the area.

The effects of the subsidence area and the tailings facility on the local watershed are analyzed in section 3.7.2.

Atmospheric Impacts

The tailings location for Alternatives 2 and 3 is located directly opposite Picketpost Mountain, a mountain sacred to Western Apache bands, and the presence of the nearly 500-foot-high tailings would constitute an adverse visual effect on the landscape.

3.14.4.4 Alternative 4 – Silver King

Direct Impacts

This alternative contains a total of 137 prehistoric and historic archaeological sites that would be adversely impacted by the combined areas of the mine; 15 of these archaeological sites have eligibility yet to be determined (see table 3.12.4-3). Three TEKPs were identified by the tribal monitors and elders. As noted earlier in this section, impacts on resources on Oak Flat would be the same for Alternative 4 and Alternatives 2 and 3. Additionally, two springs are located within and two springs are adjacent to the tailings storage facility footprint. Resources in the direct analysis area may be lost completely because of ground disturbance, or tribes may lose access to those resource once they are part of the mine.

At this time, the Tribal Monitor report of the Silver King tailings location is ongoing; full impacts for this alternative are still unknown.

Indirect Impacts

Indirect impacts may occur on the portion of an NRHP-listed TCP that is within the fence line of Alternatives 2 and 3, while the rest of the site would remain outside the fence line and would not be directly impacted. A tailings storage facility at the Alternative 4 location would reduce the surface area of the local watershed and have long-term effects on local groundwater quality due to tailings seepage (see sections 3.7.2 and 3.7.3).

Atmospheric Impacts

The Silver King tailings storage facility is east of Alternatives 2 and 3, but still within the area of sacred landscapes that would be visually compromised by the 1,040-foot-high tailings.

3.14.4.5 Alternative 5 – Peg Leg

Direct Impacts

Alternative 5 with the east pipeline option contains 197 prehistoric and historic archaeological sites; Alternative 5 with the west pipeline option contains 125 prehistoric and historic archaeological sites. Two of these sites were also recorded as TEKPs with different boundaries, and an additional TEKP that tribal monitors identified as containing a feature that matches Western Apache oral tradition was also recorded. The two proposed tailings conveyance pipeline route options are being surveyed at this time, and results will be available prior to the FEIS.

Six natural resources special interest areas, 49 plants of special interest, and five minerals of special interest would also be impacted. These resources may be lost completely because of ground disturbance, or tribes may lose access to these resources once they are part of the mine.

The surface area of the watershed would be reduced due to the permanent tailings storage facility and water quality may also be impaired due to future tailings seepage; for more detail see sections 3.7.2 and 3.7.3.

Indirect Impacts

Indirect impacts for Alternative 5 are the same as for Alternatives 2 and 3.

Atmospheric Impacts

The Peg Leg tailings storage facility would likely be visible on the horizon as far away as the town of Florence; however, no TEKPs or

TCPs have been identified in the atmospheric analysis area for the tailings impoundment. No atmospheric impacts are anticipated.

3.14.4.6 Alternative 6 – Skunk Camp

Direct Impacts

Under Alternative 6 with the north pipeline option, 323 archaeological sites would be impacted; with the south pipeline option, 318 archaeological sites would be impacted (see section 3.12.4). The surface area of the watershed would be reduced due to the permanent tailings storage facility (see section 3.7).

At this time, the Tribal Monitor study of the Skunk Camp tailings location is ongoing; full impacts for this alternative are still unknown. Resources in the direct analysis area may be lost completely because of ground disturbance.

Indirect Impacts

The indirect impacts for Alternative 6 are the same as for Alternatives 2, 3, and 5.

Atmospheric Impacts

A tailings storage facility at Skunk Camp would be only marginally visible from as far as SR 77; however, no TEKPs or TCPs have been previously identified in the atmospheric analysis area for the tailings pile. No atmospheric impacts are anticipated.

3.14.4.7 Cumulative Effects

As noted earlier , the *Chí'chil Biłdagoteel* Historic District, which comprises the Oak Flat and Apache Leap areas, is a Forest Service–recognized TCP. This project is located in an area that is important to many tribes and has been for many generations and continues to be used for cultural and spiritual purposes. No tribe supports the desecration/destruction of ancestral sites. Places where ancestors have lived are considered alive and sacred. It is a tribal cultural imperative that these places should not be disturbed or destroyed for resource extraction or for financial gain. Continued access to the land and all its resources is necessary and should be accommodated for present and future generations.

Development of the Resolution Copper Mine would permanently alter lands that hold historical, cultural, and spiritual significance for many tribal members.

This said, the following identified reasonably foreseeable future actions in the analysis area are considered also likely to affect tribal concerns and values by disrupting the landscape. As noted in section 3.1, past and present actions are assessed as part of the affected environment; this section analyzes the effects of any RFFAs, to be considered cumulatively along with the affected environment and Resolution Copper Project effects.

- *Pinto Valley Mine Expansion.* The Pinto Valley Mine is an existing open-pit copper and molybdenum mine located approximately 8 miles west of Miami, Arizona, in Gila County. Pinto Valley Mining Corporation is proposing to expand mining activities onto an estimated 1,011 acres of new disturbance (245 acres on Tonto National Forest land and 766 acres on private land owned by Pinto Valley Mining Corporation) and extend the life of the mine to 2039.
- *Ripsey Wash Tailings Project.* ASARCO is planning to construct a new tailings storage facility to support its Ray Mine operations. The environmental effects of the project were analyzed in an EIS conducted by the USACE and approved in a ROD issued in December 2018. As approved, the proposed tailings storage facility project would occupy an estimated 2,574 acres and be situated in the Ripsey Wash watershed just south of the Gila River approximately 5 miles west-northwest of Kearny, Arizona, and would contain up to approximately 750 million tons of material (tailings and embankment material).

- *Ray Land Exchange and Proposed Plan Amendment.* ASARCO is also seeking to complete a land exchange with the BLM by which the mining company would gain title to approximately 10,976 acres of public lands and federally owned mineral estate located near ASARCO's Ray Mine in exchange for transferring to the BLM approximately 7,304 acres of private lands, primarily in northwestern Arizona. It is known that at some point ASARCO wishes to develop a copper mining operation in the "Copper Butte" area west of the Ray Mine; however, no specific details are currently available as to potential environmental effects resulting from this future mining operation. The Copper Butte area contains petroglyphs and many other historic and prehistoric sites of archaeological significance that would be adversely impacted by the land exchange.
- *Silver Bar Mining Regional Landfill and Cottonwood Canyon Road.* A private firm, Mineral Mountain LLC, is proposing to develop a landfill on land the company owns approximately 6 miles southeast of Florence Junction and 4 miles due east of SR 79. This private property is an inholding within an area of BLM-administered lands and cannot be accessed without crossing BLM land. The company received Master Facility Plan Approval for the proposed landfill from ADEQ in 2009 and a BLM right-of-way grant in 2017. As noted in the EA and FONSI for the right-of way, road improvements to allow for heavy truck haul traffic across BLM lands would adversely affect six cultural sites. This development would contribute to the overall regional changes adversely affecting traditional tribal cultural practices and places that have significance to tribal cultural identities.
- *Tonto National Forest Plan Amendment and Travel Management Plan.* The Tonto National Forest is currently in the process of revising its Forest Plan to replace the plan now in effect, which was implemented in 1985. Simultaneously, the Tonto National Forest is developing a Supplemental EIS to address certain court-identified deficiencies in its 2016 Final Travel Management Rule EIS. Both documents and their respective implementing decisions are expected within the next 2 years. Cultural resources may be impacted for any new road construction; however, the Tonto National Forest would conduct the appropriate surveys, consultation, and mitigation. Impacts on these sites would cumulatively impact cultural resources in the area in combination with the loss of sites that would take place with the Resolution Copper Project. Changes in travel management could change the locations in which people recreate or travel within the Tonto National Forest; while this has been considered and addressed for the Apache Leap SMA, other areas of importance to tribes may be impacted in this way. These impacts would be cumulative with the overall impacts on tribal cultural practices and places caused by the Resolution Copper Project.

Southwestern tribal historical and cultural affiliations, trading networks, and other intertribal communication pathways existed long before present-day governmental and administrative boundaries (including international boundaries) and continue to exist irrespective of current geographical demarcations. For this reason, it is recognized that in addition to the Resolution Copper Project, mining projects and other human-induced development expected to occur in the Copper Triangle, in the southwestern United States, and possibly elsewhere may also contribute to adversely affecting traditional tribal cultural practices and places that have significance to tribal cultural identities.

3.14.4.8 Mitigation Effectiveness

None of the tribes affiliated with the area believe the impacts on tribal resources can be mitigated.

The Forest Service is in the process of developing a robust mitigation plan to avoid, minimize, rectify, reduce, or compensate for resource impacts that have been identified during the process of preparing this EIS. Appendix J contains descriptions of mitigation concepts being considered and known to be effective, as of publication of the DEIS. Appendix J also contains descriptions of monitoring that would be needed to identify potential impacts and mitigation effectiveness. As noted in chapter 2 (section 2.3), the full suite of mitigation would be contained in the FEIS, required by the ROD, and ultimately included in the final GPO approved by the Forest Service. Public comment on the EIS, and in particular appendix J, will inform the final suite of mitigations.

This section contains an assessment of the effectiveness of design features from the GPO and mitigation and monitoring measures found in appendix J that are applicable to tribal concerns.

Mitigation Measures Applicable to Tribal Resources

Other mitigations could be developed via government-to-government consultation or through the consultations required by the NDAA. The mitigations that would arise through these processes could be kept confidential and would not be disclosed to the public in the DEIS or FEIS.

Two applicant-committed environmental protection measures (see section 3.14.4.2) evolved through these other consultations. The Tribal Monitor Program and Emory Oak Restoration highlight consultation and mitigation of project affects.

Conduct cultural and archaeological data recovery via the Oak Flat HPTP (RC-209): The Oak Flat Historic Properties Treatment Plan (HPTP) sets out a plan for treatments to resolve the adverse effects on 42 historic properties that have been identified within the Oak Flat Federal Parcel. In accordance with the plan, Resolution Copper would conduct archaeological data recovery on sites eligible under Criterion D that would be adversely affected. Project materials and archaeological collections would be curated in accordance with 36 CFR 79 (Curation of Federally-Owned and Administered Archaeological Collections) with Gila River Indian Community, Salt River Pima-Maricopa Indian Community, and the Arizona State Museum. This measure is applicable to all alternatives and would be noted in the ROD/Final Mining Plan of Operations.

Conduct cultural and archaeological data recovery via the Research Design and data recovery plans (RC-210): The GPO Research Design and data recovery plans detail treatments to resolve adverse effects on historic properties within the GPO project area, with the exception of those in the Oak Flat Federal Parcel. Data recovery would be conducted on archaeological sites eligible under Criterion D within the GPO project area. Project materials and archaeological collections would be curated in accordance with 36 CFR 79 (Curation of Federally-Owned and Administered Archaeological Collections) with Gila River Indian Community, Salt River Pima-Maricopa Indian Community, and the Arizona State Museum. This measure is applicable to all alternatives and would be noted in the ROD/Final Mining Plan of Operations.

Mitigation Effectiveness and Impacts

According to the tribes consulted, adverse impacts on TCPs, TEKPs, and other places or resources of significant interest to tribes cannot be mitigated; therefore, mitigation strategies for tribal resources are designed to provide an exchange for the loss of resources. The mitigation strategies will have, and are having, positive impact on tribal communities such as providing jobs during the tribal monitoring and allowing unfettered access to Emory oak resources.

Unavoidable Adverse Impacts

Significant tribal properties and uses would be directly and permanently impacted. These impacts cannot be avoided within the areas of direct impact, nor can they be fully mitigated.

3.14.4.9 Other Required Disclosures

Short-Term Uses and Long-Term Productivity

Physical and visual impacts on TCPs, TEKPs, and plant and mineral resources caused by construction of the mine would be immediate, permanent, and large in scale. Mitigation measures cannot replace or replicate the tribal resources and traditional cultural properties that would be destroyed by project construction. The landscape, which is imbued with specific cultural attributions by each of the consulted tribes, would also be permanently affected.

Irreversible and Irretrievable Commitment of Resources

The direct impacts on TCPs and TEKPs from construction of the mine and associated facilities constitute an irreversible commitment of resources. Traditional cultural properties cannot be reconstructed once disturbed, nor can they be fully mitigated. Sacred springs would be eradicated by subsidence or tailings storage construction and affected by groundwater water drawdown. Changes that permanently affect the ability of tribal members to use known TCPs and TEKPs for cultural and religious purposes are also an irreversible commitment of resources. For uses such as gathering traditional materials from areas that would be within the subsidence area or the tailings storage facility, the project would constitute an irreversible commitment of resources.

Overview

For many decades, the development of mines, dams, freeway systems, and many other kinds of infrastructure and commercial projects that have proved generally beneficial to society as a whole have often adversely and disproportionately affected minority populations and the poor—those least able to effectively speak out against environmental or economic damage to their homes, health, and lifestyles. Executive Order 12898, signed by President Clinton in 1994, requires Federal agencies to consider environmental justice issues in decision-making on projects that have the potential to harm vulnerable or disadvantaged communities. This section examines environmental justice issues in the context of the Resolution Copper Project and Land Exchange.

3.15 Environmental Justice

3.15.1 Introduction

Environmental justice is intended to promote the fair treatment and meaningful involvement of all people—regardless of race, ethnicity, or income level—in Federal environmental decision-making. Environmental justice programs encourage active public participation and the dissemination of relevant information to inform and educate communities that may be adversely affected by a proposed project or its alternatives.

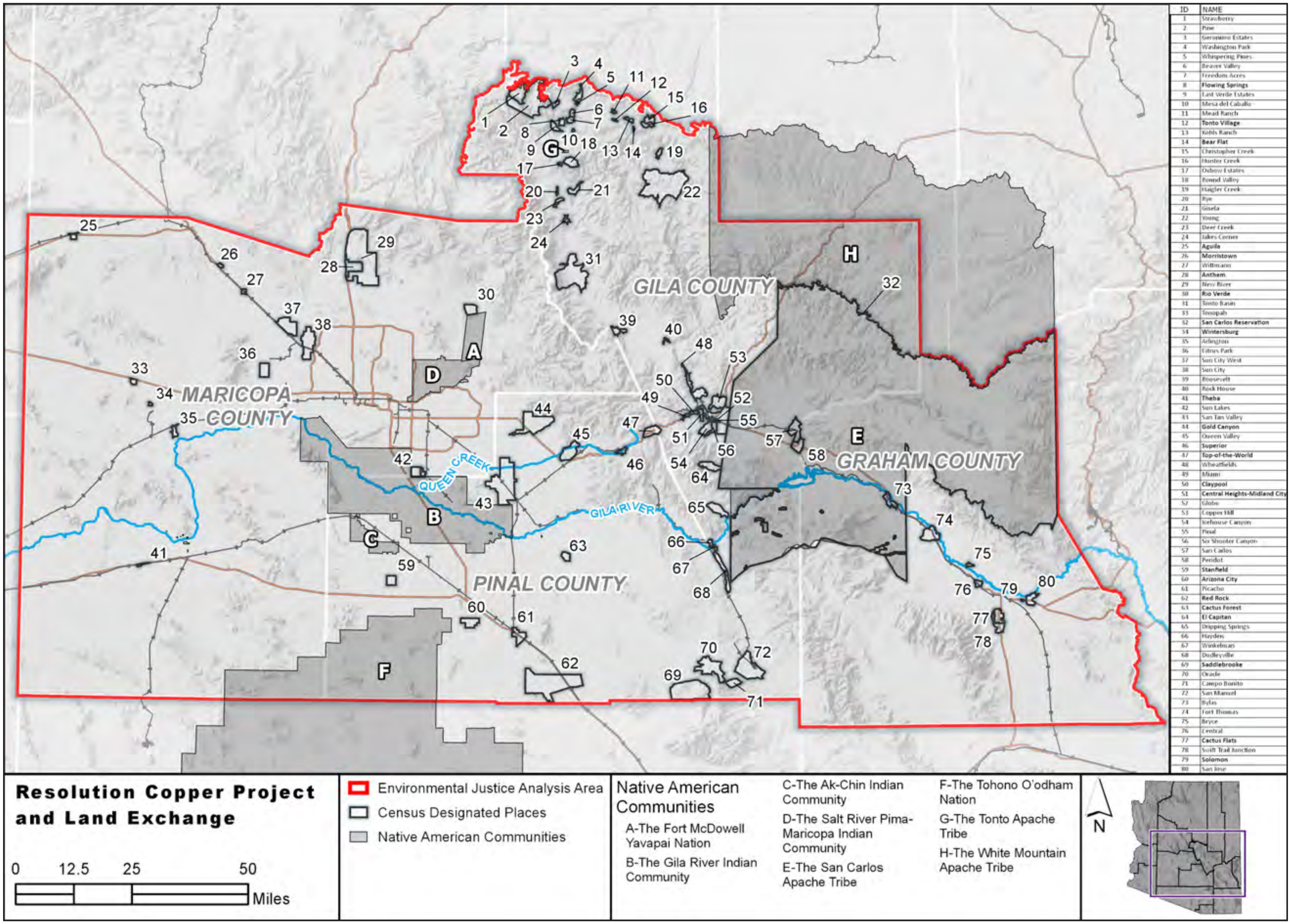
As detailed in Chapter 1, Section 1.6, Public Involvement, the public (including members of environmental justice communities identified later in this section) has been meaningfully involved in the NEPA process. Public involvement included a 120-day scoping period during which five scoping meetings were held. These meetings provided the public with an opportunity to ask questions, learn more about the proposed project, and provide comments on issues and concerns that should be addressed in the EIS and alternatives that should be evaluated. Additionally, three public alternatives development workshops were held (two in person and one online) to solicit input on criteria for the selection of locations for the tailings storage facilities. Native American communities are involved in ongoing consultation with the Forest Service (see Section 1.6.4, Tribal Consultation; and Chapter 4, Consulted Parties).

This section determines which communities in the analysis area are considered environmental justice communities, based on minority status or poverty status, and then assesses the potential effects of each alternative on environmental justice communities.

3.15.2 Analysis Methodology, Assumptions, and Uncertain and Unknown Information

3.15.2.1 Analysis Area

The geographic area for the analysis of potential environmental justice impacts includes communities (such as cities, towns, and Census Designated Places [CDPs]) within Gila, Graham, Maricopa, and Pinal Counties. Native American communities within this analysis area are also included (figure 3.15.2-1). Although the extent of potential project-related impacts would likely be limited to a smaller, more regional area, this four-county analysis area was determined to be appropriate in order to capture the extent of potential measurable socioeconomic effects. While the region with the potential for project-related impacts is located in Pinal and Gila Counties, Maricopa County was also included because a substantial portion of the workforce for the proposed mine would be expected to commute from the Phoenix metropolitan area, and Graham County was included because of its proximity to the project area and large Native American population.



ID	NAME
1	Strawberry
2	Pine
3	Geronimo Estates
4	Washington Park
5	Whispering Pines
6	Beaver Valley
7	Freedom Acres
8	**Flowing Springs**
9	East Verde Estates
10	Mesa del Caballo
11	Mead Ranch
12	**Tonto Village**
13	Kohls Ranch
14	**Bear Flat**
15	Christopher Creek
16	Hunter Creek
17	Oxbow Estates
18	Round Valley
19	Haigler Creek
20	Rye
21	Gisela
22	Young
23	Deer Creek
24	Jakes Corner
25	**Aguila**
26	**Morristown**
27	Wittmann
28	**Anthem**
29	New River
30	**Rio Verde**
31	Tonto Basin
33	Tonopah
32	**San Carlos Reservation**
34	**Wintersburg**
35	Arlington
36	Citrus Park
37	Sun City West
38	Sun City
39	Roosevelt
40	Rock House
41	**Theba**
42	Sun Lakes
43	San Tan Valley
44	**Gold Canyon**
45	Queen Valley
46	**Superior**
47	**Top-of-the-World**
48	Wheatfields
49	Miami
50	**Claypool**
51	**Central Heights-Midland City**
52	Globe
53	Copper Hill
54	Icehouse Canyon
55	Pinal
56	Six Shooter Canyon
57	San Carlos
58	Peridot
59	**Stanfield**
60	**Arizona City**
61	Picacho
62	**Red Rock**
63	**Cactus Forest**
64	**El Capitan**
65	Dripping Springs
66	Hayden
67	Winkelman
68	Dudleyville
69	**Saddlebrooke**
70	Oracle
71	Campo Bonito
72	San Manuel
73	Bylas
74	Fort Thomas
75	Bryce
76	Central
77	**Cactus Flats**
78	Swift Trail Junction
79	**Solomon**
80	San Jose

Figure 3.15.2-1. Environmental justice analysis area

3.15.2.2 Methodology for Determining Environmental Justice Communities

The CEQ defines a community with potential environmental justice populations as one that has a greater percentage of minority and/or low-income populations than does an identified reference community. Minority populations are those populations that have the following characteristics:

1. A readily identifiable group of people with a population that is at least 50 percent minority living in geographic proximity to the project area. The population exceeding 50 percent minority may be made up of one minority or a number of different minority groups; together, the sum is 50 percent or greater.
2. A minority population may be an identifiable group that has a meaningfully greater minority population than the adjacent geographic areas, or may also be a geographically dispersed/transient set of individuals, such as migrant workers or Native Americans (Council on Environmental Quality 1997).

In 2014, the Forest Service updated its environmental justice analysis process in "Striving for Inclusion: Addressing Environmental Justice for Forest Service NEPA" (Periman and Grinspoon 2014). In this guidance document, the Forest Service recommends using the second approach as the more inclusive of the two: identify groups that have meaningfully greater minority populations than adjacent geographic areas. A "meaningfully greater" minority population is not defined in this document; however, for the purpose of this analysis, "meaningful greater" is defined as a difference of more than 5 percent between the communities and the reference area.

This approach makes selection of the reference area an important factor. Because of the project's large scale, the geographic area used as a reference is the state of Arizona. Within the four-county analysis area, environmental justice communities are those municipal areas and communities that are distinguished as having a minority and/or low-income population meaningfully greater than this reference area.

The 2014 guidance document also recommends identifying low-income populations with the annual statistical poverty thresholds from the U.S. Census Bureau's annual current population reports (Series P-60) on income and poverty. The U.S. Census Bureau defines 2017 poverty-level thresholds (the year for which demographic data are available for communities within the analysis area) for individuals and a family of four as income levels below $12,488 and $25,094, respectively (U.S. Census Bureau 2019). The same "meaningful greater" definition of a difference of 5 percent or more between the communities and the reference area is also used for low-income environmental justice populations.

Potential adverse impacts for each resource area are evaluated for impacts that would be considered "disproportionately high or adverse." In instances where an impact from the proposed action may appear to be identical to both the affected general population and the affected minority populations and low-income populations, there may be related factors that amplify the impact. These factors can include proximity (such as impacts limited in geographic scope to adjacent low-income or minority communities), economic (such as if the economic burden of a proposed project does not outweigh the benefit to low-income or minority communities), health or safety (such as the presence of unique exposure pathways and/or social determinants of health of minority or low-income communities), or social/cultural (such as impacts on resources or places important to cultural traditions of minority or low-income communities).

3.15.3 Affected Environment

3.15.3.1 Relevant Laws, Regulations, Policies, and Plans

A complete listing and brief description of the legal authorities, reference documents, and agency guidance applicable to environmental justice may be reviewed in Newell (2018b).

3.15.3.2 Existing Conditions and Ongoing Trends

Minority Populations

Using the methodology described in section 3.15.2, we identified 29 locations where the minority (nonwhite) population is more than 5 percent greater than the reference community (table 3.15.3-1) in addition to the following eight Native American lands and associated communities:

1. White Mountain Apache Tribe (which includes the Carrizo, Cedar Creek, and Canyon Day CDPs)
2. Fort McDowell Yavapai Nation
3. Gila River Indian Community (which includes the Maricopa Colony, St. Johns, Komatke, Gila Crossing, Santa Cruz, Sacate Village, Goodyear Village, Casa Blanca, Wet Camp Village, Sweet Water Village, Stotonic Village, Lower Santan Village, Upper Santan Village, Sacaton, Sacaton Flats, and Blackwater CDPs)
4. Ak-Chin Indian Community (which includes the Ak-Chin Village CDP)
5. Salt River Pima-Maricopa Indian Community
6. San Carlos Apache Tribe (which includes the East Globe, San Carlos, Peridot, and Bylas CDPs),
7. Tohono O'odham Nation (which includes the Chuichu, Vaiva Vo, Tat Momoli, Kohatk, and Kaka CDPs, as well as the satellite village of Florence Village)
8. Tonto Apache Tribe

These locations meet the minority criteria for identification as an environmental justice community. Table 3.15.3-1 summarizes relevant census data regarding minority (nonwhite) populations for the analysis area.

Populations Living Below Poverty Level

Using the methodology described in section 3.15.2, there are 35 locations within the analysis area where the populations of individuals and/or families living below poverty level exceed the reference community by greater than 5 percent (see table 3.15.3-1). Therefore, these locations meet the poverty criteria for identification as an environmental justice community. Table 3.15.3-1 summarizes relevant data for the percentage of individuals living below poverty level and percentage of families living below poverty level in the analysis area.

Primary Legal Authorities Relevant to the Environmental Justice Effects Analysis

- Executive Order 12898, "Environmental Justice in Minority Populations and Low-Income Populations" (1994)
- Forest Service Guide "Striving for Inclusion: Addressing Environmental Justice for Forest Service NEPA" (2014)
- U.S. Census 5-Year American Community Survey for the State of Arizona (2013–2017)

Table 3.15.3-1. Percent minority population and percent population living below poverty level

Geographic Area	County	Minority Population Percentage*	Percentage of Individuals Living Below Poverty Level	Percentage of Families Living Below Poverty Level
State of Arizona		**44.4**	**17.0**	**12.3**
Aquila CDP	Maricopa	95.9	58.5	42.2
Arizona City CDP	Pinal	49.7	–	–
Avondale CDP	Maricopa	67.2	–	–
Bryce CDP	Graham	–	37.7	–
Cactus Flats CDP	Graham	–	34.2	26.5
Casa Blanca CDP	Pinal	91.2	60.1	44.4
City of Casa Grande	Maricopa	55.0	–	–
City of Coolidge	Pinal	57.9	24.2	19.3
Dudleyville CDP	Pinal	73.4	29.9	19.5
East Verde Estates CDP	Gila	–	26.3	17.6
City of El Mirage	Maricopa	59.9	–	–
City of Eloy	Pinal	77.5	32.5	17.2
Town of Florence	Pinal	52.3	–	–
Flowing Springs CDP	Gila	54.5	27.3	–
Freedom Acres CDP	Gila	–	37.2	19.6
Town of Gila Bend	Maricopa	74.5	37.8	33.0
Gisela CDP	Gila	–	37.5	36.4
City of Glendale	Maricopa	51.4	–	–
City of Globe	Gila	–	–	17.8
Town of Guadalupe	Maricopa	95.1	32.7	31.4
Haigler Creek CDP	Gila	–	37.9	–
Town of Hayden	Gila	88.4	29.8	23.9
Icehouse Tavern CDP	Gila	–	25.4	–
Town of Kearny	Pinal	57.3	21.7	–
Town of Mammoth	Pinal	75.9	23.8	–
Town of Miami	Gila	66.0	28.6	24.1
Morristown CDP	Maricopa	–	25.3	–
Oxbow Estates CDP	Gila	–	–	29.2
City of Phoenix	Maricopa	56.7	20.9	–
Picacho CDP	Pinal	69.6	24.1	21.2
Town of Pima	Graham	–	24.5	28.3

continued

Table 3.15.3-1. Percent minority population and percent population living below poverty level *(cont'd)*

Geographic Area	County	Minority Population Percentage*	Percentage of Individuals Living Below Poverty Level	Percentage of Families Living Below Poverty Level
Pinal CDP	Gila	–	30.8	20.0
Round Valley CDP	Gila	–	50.8	–
City of Safford	Graham	49.7	–	–
San Jose CDP	Graham	78.5	–	–
San Manuel CDP	Pinal	56.9	23.7	17.5
Six Shooter Canyon CDP	Gila	–	–	19.0
Soloman CDP	Graham	79.2	–	–
Stanfield CDP	Pinal	89.9	–	29.3
Town of Star Valley	Gila	–	24.7	–
Town of Superior	Pinal	69.6	–	–
Swift Trail Junction CDP	Graham	53.9	–	–
City of Tolleson	Maricopa	91.2	23.3	20.0
Whispering Pines CDP	Gila	–	29.2	50.0
Town of Winkelman	Pinal	82.4	–	–
Wittman CDP	Maricopa	–	–	24.8
Town of Youngtown	Maricopa	–	22.7	16.8

Source: U.S. Census Bureau, 2013–2017 American Community Survey 5-Year Estimates (U.S. Census Bureau 2018)

Note: Dash indicates the community did not exceed the State of Arizona reference level by 5 percent or more.

* Nonwhite population is calculated by subtracting values in the field “Only one race – white alone” from the field “total population.” Nonwhite in this analysis thus refers to all individuals who self-identify either as Hispanic, including Hispanic whites, or as a race other than white alone.

3.15.4 Environmental Consequences of Implementation of the Proposed Mine Plan and Alternatives

3.15.4.1 Alternative 1 – No Action Alternative

Under the no action alternative, adverse impacts on environmental justice populations other than Native American communities would not occur, as the current land use would remain unchanged and opportunities for disproportionate adverse impacts would not exist.

3.15.4.2 Impacts Common to all Action Alternatives

Not all of the communities that meet the criteria (described in section 3.15.2) for an environmental justice population within the four-county analysis area would potentially experience measurable impacts from the alternatives analyzed in this section; therefore, the communities for which impacts are analyzed are listed here. The remaining populations are either outside the potential geographic extent of potential impacts or would experience beneficial socioeconomic effects (see section 3.13 for a more detailed discussion of potential impacts on socioeconomics).

The proposed project has the potential to disproportionately impact the eight identified Native American communities and the following five communities:

1. town of Hayden
2. town of Miami
3. city of Globe
4. town of Superior
5. town of Winkelman

Effects of the Land Exchange

The land exchange would have effects on some environmental justice communities.

The Oak Flat Federal Parcel would leave Forest Service jurisdiction and no longer be open to public use to those communities in the vicinity. The offered lands that would enter either Forest Service or BLM jurisdiction would be beneficial to nearby communities of each parcel.

Native American communities would be disproportionately affected by the land exchange because Oak Flat would be conveyed to private property and would no longer be subject to the NHPA (see section 3.12). Loss of the culturally important area of Oak Flat would be a substantial threat to the perpetuation of cultural traditions of the Apache and Yavapai tribes. The land exchange would have a disproportionally adverse effect on Native American communities as a result of the effects on tribal values and concerns and cultural resources.

Effects of Forest Plan Amendment

The Tonto National Forest Land and Resource Management Plan (1985b) provides guidance for management of lands and activities within the Tonto National Forest. It accomplishes this by establishing a mission, goals, objectives, and standards and guidelines. Missions, goals, and objectives are applicable on a forest-wide basis. Standards and guidelines are either applicable on a forest-wide basis or by specific management area.

A review of all components of the 1985 forest plan was conducted to identify the need for amendment due to the effects of the project, including both the land exchange and the proposed mine plan (Shin 2019). No standards and guidelines were identified as applicable to environmental justice. For additional details on specific rationale, see Shin (2019).

Summary of Applicant-Committed Environmental Protection Measures

A number of environmental protection measures are incorporated into the design of the project that would act to reduce potential impacts on environmental justice communities. These are non-discretionary measures, and their effects are accounted for in the analysis of environmental consequences. Because they cover a variety of resources (see list in next section), these measures are not repeated here.

Potential Effects on Environmental Justice Communities by Resource

Under all action alternatives, impacts on environmental justice communities from the East Plant Site and West Plant Site, subsidence area, and from auxiliary facilities for the East Plant Site and West Plant Site (such as transmission lines, pipelines, and roads) would be similar because the locations of these facilities across all action alternatives would not change impacts on environmental justices communities. However, impacts on environmental justice communities from the proposed tailings storage facilities and auxiliary facilities would vary under each of the action alternatives and therefore are discussed separately later in this section.

For detailed differences between alternatives by resource, see the respective resource analyses in the "Environmental Consequences" parts of each resource section. For many resources (e.g., geology, wildlife, and soils and vegetation), potential adverse impacts resulting from the action alternatives would be generally limited to the project area. Because there are no communities located within the project area, there would not be disproportionately high or adverse direct impacts on environmental justice communities as a result of disturbance. Resources that may be subject to adverse impacts as a result of the action alternatives and that may have subsequent disproportionately high or adverse impacts on environmental justice communities are

- scenic resources,
- socioeconomics,
- public health and safety,
- recreation,
- transportation and access,
- noise and vibration,
- land ownership and access,
- water resources,
- air quality,
- tribal values and concerns, and
- cultural resources.

During analysis, we considered these resources and whether the action alternatives would result in a disproportionate impact on environmental justice communities; the rationale is included in table 3.15.4-1.

As indicated in table 3.15.4-1, we anticipate that the proposed East Plant Site, West Plant Site, area of subsidence, and auxiliary facilities would have disproportionately high and adverse impacts on environmental justice communities for scenic resources and dark skies. Impacts on these resources would be largely experienced by the town of Superior. In addition, impacts on cultural resources and tribal concerns and values would have a disproportionally adverse impact on Native American communities. Other environmental justice communities (with the exception of Native American communities) would not experience adverse impacts as a result of the proposed project because they would be located outside the geographic area of influence for most resources. The town of Superior would experience disproportionately high and adverse impacts under all alternatives primarily because the West Plant Site and associated facilities would be located directly north of and adjacent to the town.

Table 3.15.4-1. Identified resources and determination of adverse impact on environmental justice communities

Resource or Resource Use	Is There an Adverse Impact on an Environmental Justice Community?	Is the Impact Disproportionately High and Adverse?
Geology, Minerals, and Subsidence	No	**No.** As potential impacts on geological and/or mineral resources are anticipated to be limited beyond the geographic scope of the project area, and environmental justice communities are not located within the project area, it is unlikely that direct or indirect impacts on these resources would affect these communities. In addition, the geological and/or mineral resources located within the project area are also present in areas outside of the area that may be disturbed. Therefore, because the impacts on geological or mineral resources would be limited in geographic scope and would not result in the total loss of these resources across the region, these impacts are not anticipated to result in adverse impacts on environmental justice communities. Subsidence effects would be limited to Resolution Copper private land.
Scenic Resources	Yes	**Yes.** Residents of the town of Superior would experience adverse changes to visual quality of the area as a result of the West Plant Site and auxiliary facilities. As the town of Superior would be the only community that would experience adverse impacts on scenic resources as a result of the West Plant Site and auxiliary facilities and has been identified as an environmental justice community, impacts on scenic resources would be disproportionately adverse.
Scenic Resources: Dark Skies	Yes	**Yes.** The town of Superior would experience an increase in sky brightness between 40 and 160 percent as a result of the West Plant Site and auxiliary facilities. As the town of Superior would be the only community that would experience adverse impacts on dark skies from increased levels of light pollution as a result of the West Plant Site and auxiliary facilities, and has been identified as an environmental justice community, these impacts would be disproportionately adverse.
Socioeconomics	Yes	**No.** All environmental justice communities would experience socioeconomic impacts (see section 3.13), such as an increase in tax revenues and direct and indirect employment opportunities resulting in beneficial multiplier effects for the majority of the identified communities. Increases in direct and indirect revenues from the proposed project could result in net beneficial economic impacts across the analysis area. The proposed project could result in an increase in direct and indirect employment opportunities for members of environmental justice communities, thus having a beneficial multiplier effect on environmental justice communities. Adverse impacts on property values would be largely limited to residences near the proposed tailings storage facilities, of which only the town of Superior has been identified as an environmental justice community; however, it is anticipated that adverse impacts on property values from proposed tailings storage facilities would be offset by upward pressure on property values related to increased housing demand from the mine workforce, and from the applicant-committed measures specific to the town of Superior that are described in section 3.13.
Public Health and Safety: Fire and Fuels Management	Yes	**No.** The town of Superior is identified as a Wildland Urban Interface community at high risk from wildfire and would experience an increase in risk of wildfire; however, these impacts would not be limited to environmental justice communities.
Public Health and Safety: Hazardous Materials	Yes	**No.** The risk for catastrophic release of hazardous materials is highest during transportation, and these materials would be transported by truck along U.S. 60, which is partially located within the town of Superior; however, other communities within which U.S. 60 is also partially located and through which hazardous materials may be transported have not been identified as environmental justice communities. Therefore, these impacts would not be limited to environmental justice communities.

continued

Table 3.15.4-1. Identified resources and determination of adverse impact on environmental justice communities *(cont'd)*

Resource or Resource Use	Is There an Adverse Impact on an Environmental Justice Community?	Is the Impact Disproportionately High and Adverse?
Recreation	Yes	**No.** Impacts on recreation would not be limited to environmental justice communities.
Transportation and Access	Yes	**No.** The town of Superior would experience an increase in level of service to inadequate rankings of E or F at five intersections; however, these impacts would affect both residents of the town of Superior as well as visitors and would not be limited to members of environmental justice communities.
Noise and Vibration	Yes	**No.** Noise and vibration from construction-related activities (underground blasting and construction equipment at surface level) at the West Plant Site and underground conveyance tunnel would result in short-term and intermittent increases in noise and vibration levels that may exceed applicable thresholds for some individual residences in the town of Superior; however, because of the short-term and infrequent nature of construction activities, the effects are not anticipated to be adverse. During operations, the long-term increase in noise and vibration from the proposed project at the West Plant Site, in conjunction with existing background noise and vibration, is expected to result in increased levels of noise and vibration within the town of Superior; however, because these levels would not exceed applicable thresholds, the proposed action would therefore not disproportionately impact environmental justice communities.
Soils and Vegetation	No	**No.** As potential impacts on soils and vegetation resources are anticipated to be limited beyond the geographic scope of the project area and environmental justice communities are not located within the project area, it is unlikely that direct or indirect impacts on these resources would affect these communities. In addition, the soils and vegetation resources located within the project area are also present in areas outside the area that may be disturbed. Therefore, because the impacts on these resources would be limited in geographic scope and would not result in the total loss of these resources across the region, these impacts are not anticipated to result in adverse impacts on environmental justice communities. Loss of access to resource-gathering areas is discussed in "Tribal Values and Concerns" within this table.
Land Use: Land Ownership and Access	Yes	**No.** Loss of access to public lands would not be limited to environmental justice communities.
Land Use: Livestock and Grazing	No	**No**. As potential impacts on livestock and grazing are anticipated to be limited beyond the geographic scope of the project area and livestock grazing has not been identified as a critical economic or cultural critical land use within the project area for environmental justice communities, it is unlikely that changes to livestock grazing would result in impacts on these communities.
Water Quantity: Groundwater	No	**No.** Additional drawdown due to block-caving is anticipated for water supply wells in and around the town of Superior, except for those completed solely in alluvium or shallow fracture systems. Impacts could include loss of well capacity, the need to deepen wells, the need to modify pump equipment, or increased pumping costs. However, Resolution Copper has identified an applicant-committed environmental protection measure that would replace water supplies lost.

continued

Table 3.15.4-1. Identified resources and determination of adverse impact on environmental justice communities *(cont'd)*

Resource or Resource Use	Is There an Adverse Impact on an Environmental Justice Community?	Is the Impact Disproportionately High and Adverse?
Water Quantity: Surface Water	Yes	**No.** Impacts on surface water quantity would not be limited to environmental justice communities.
Water Quality: Groundwater	Yes	**No.** Potential impacts on groundwater quality would not be limited to environmental justice communities.
Water Quality: Surface Water	Yes	**No.** Potential impacts on surface water quality would not be limited to environmental justice communities.
Air Quality	Yes	**No.** The effects on air quality as a result of emissions from the proposed project, in conjunction with nearby source emissions, are expected to result in predicted concentrations in Class I and II areas that are in compliance with the NAAQS limits and would therefore not disproportionately impact environmental justice communities.
Tribal Values and Concerns	Yes	**Yes.** Disturbance to and loss of access to sacred sites, traditional cultural properties, and traditional resource collecting areas within the proposed mine area would adversely impact members of the consulting tribes. No tribe supports the desecration or destruction of ancestral sites. As this impact would be limited to Native American communities and the permanent loss of these resources is not able to be mitigated, impacts would be disproportionately high and adverse.
Cultural Resources	Yes	**Yes.** Disturbance to historic properties within the proposed mine area would adversely impact cultural resources and members of the consulting tribes (see Section 3.14, Tribal Values and Concerns).
Wildlife	No	**No.** As potential impacts on wildlife resources are anticipated to be limited beyond the geographic scope of the project area and environmental justice communities are not located within the project area and wildlife has not been identified as a critical economic or cultural critical land use (e.g., hunting) within the project area for environmental justice communities, it is unlikely that changes to wildlife or wildlife habitats would result in impacts on these communities.

The tribal values and concerns resource section (see section 3.14) indicates that during consultation with Native American tribes, the tribes requested that tribal monitors resurvey a number of geographic areas to identify traditional cultural properties of importance to the four cultural groups with ties to the region (Puebloan, O'odham, Apache, and Yavapai). Traditional cultural properties can include springs and seeps, plant and mineral resource collecting areas, landscapes and landmarks, caches of regalia and human remains, and sites that may not have been recognized by non-Native archaeologists. Representatives of the Yavapai and Apache tribes have identified a number of areas that may be directly or indirectly affected by all alternatives as sacred landscapes and/or TCPs. Additionally, all of the consulting tribes consider all springs and seeps sacred, and all of the tribes strongly object to the development of a mine and placement of tailings in any culturally sensitive area. Although the physical boundaries of the reservations of the consulting tribes are not within the project area boundaries, disturbance of the sites would result in a disproportionate impact on the tribes, given their historical connection to the land. Additionally, the potential impacts on archaeological and cultural sites (see section 3.12) are directly related to the tribes' concerns and the potential impacts on cultural identity and religious practices. Given the known presence of ancestral villages, human remains, sacred sites, and traditional resource-collecting areas that have the potential to be permanently affected, it is unlikely that compliance and/or mitigation would substantially relieve the disproportionality of the impacts on the consulting tribes.

Impacts on scenic quality and dark skies (see section 3.11) as a result of the development of the West Plant Site and auxiliary facilities would be disproportionally high and adverse for residents of the town of Superior, as it would be located directly adjacent to developed areas of the town. Views from residences and community areas within 2 miles of the West Plant Site could be impacted by a strong change in landscape form, line, color, and texture and the dominance of new landscape features in the view. In addition, the magnitude of the increase in sky brightness that would occur as a result of the West Plant Site and auxiliary facilities would be disproportionally experienced by adjacent residences. Given the proximity of residences to the West Plant Site, it is unlikely that compliance and/or mitigation would substantially relieve the disproportionality of the impacts on the affected community members.

Impacts on potential environmental justice communities that could

result from the proposed tailings storage facilities are discussed by alternative in the following text. Impacts on resources that would not be disproportionately high and adverse are not discussed.

3.15.4.3 Alternatives 2 and 3 – Near West

Effects from the tailings storage facility and auxiliary facilities under Alternatives 2 and 3 that are anticipated to have disproportionately high and adverse impacts on environmental justice communities include cultural resources and tribal values and concerns. For these resources, impacts would be similar to those described in Section 3.15.4.3, Impacts Common to All Action Alternatives.

The proposed location of the Alternatives 2 and 3 tailings storage facilities contains culturally important areas (see section 3.14), as well as a number of archaeological sites that would be adversely impacted by either alternative (see section 3.12). In addition, these alternatives are located in proximity to an identified sacred site, and the presence of the tailings storage facility would constitute an adverse visual effect on the landscape (see sections 3.11 and 3.14). This alternative would result in disproportionately high and adverse impacts on cultural resources and tribal values and concerns.

3.15.4.4 Alternative 4 – Silver King

Effects from the tailings storage facility and auxiliary facilities under Alternative 4 that are anticipated to have disproportionately high and adverse impacts on environmental justice communities include scenic resources, cultural resources, and tribal values and concerns. Impacts would be similar to those described earlier in Section 3.15.4.3, Impacts Common to All Action Alternatives, for cultural resources and tribal values and concerns.

The location of this proposed tailings storage facility contains culturally important areas (see section 3.14), as well as a number of archaeological sites that would be adversely impacted (see section 3.12). Even though this alternative is located east of Alternatives 2 and 3, it would still be visible on the landscape (see sections 3.11 and 3.14). This alternative would result in disproportionately high adverse impacts on cultural resources and tribal values and concerns.

Impacts on scenic quality (see section 3.11) as a result of the development of the proposed tailings storage facility and auxiliary facilities would be disproportionally high and adverse for residents of the town of Superior, as it would be located directly adjacent to the community. Prior to reclamation activities, as the embankment grows, the facility would become increasingly visible from the town of Superior. Views from residences and community areas could be impacted by a moderate to strong change in landscape form, line, color, and texture and the dominance of new landscape features in the view. Given the level of scenic change for residents of the town of Superior that would result from this alternative, it is unlikely that compliance and/or mitigation would substantially relieve the disproportionality of the impacts on the affected community members.

3.15.4.5 Alternative 5 – Peg Leg

Effects from the tailings storage facility and auxiliary facilities under Alternative 5 that are anticipated to have disproportionately high and adverse impacts on environmental justice communities include cultural resources and tribal values and concerns. Impacts would be similar to those described in Section 3.15.4.3, Impacts Common to All Action Alternatives.

The location of this proposed tailings storage facility contains culturally important areas (see section 3.14), as well as a number of archaeological sites that would be adversely impacted by either of the proposed tailings pipeline routes (see section 3.12). This alternative would result in disproportionately high adverse impacts on cultural resources and tribal values and concerns.

3.15.4.6 Alternative 6 – Skunk Camp

Effects from the tailings storage facility and auxiliary facilities under Alternative 6 that are anticipated to have disproportionately high and adverse impacts on environmental justice communities include cultural resources and tribal values and concerns; impacts would be similar to those described in Section 3.15.4.3, Impacts Common to All Action Alternatives.

The location of this proposed tailings storage facility contains culturally important areas (see section 3.14), as well as a number of archaeological sites that would be adversely impacted by either of the proposed tailings pipeline routes (see section 3.12). In addition, the proposed pipeline corridors associated with this alternative would both be located in proximity to identified sacred sites, and the presence of the pipeline corridors would constitute an adverse visual effect on the landscape (see section 3.14). It can also be anticipated that this alternative would result in disproportionately high and adverse impacts on cultural resources and tribal values and concerns.

3.15.4.7 Cumulative Effects

The Tonto National Forest identified the following list of reasonably foreseeable future actions as likely to occur in conjunction with development of the Resolution Copper Mine. These reasonably foreseeable future actions are expected to contribute to cumulative changes to low-income and/or minority populations protected by Title VI of the Civil Rights Act and environmental justice conditions in the towns of Superior and Florence and other nearby communities, particularly those in northern Pinal County, southwestern Gila County, and eastern Maricopa County. As noted in section 3.1, past and present actions are assessed as part of the affected environment; this section analyzes the effects of any reasonably foreseeable future actions, to be considered cumulatively along with the affected environment and Resolution Copper Project effects.

Many of the RFFAs can also be anticipated to result in disproportionately high and adverse impacts on Native American

communities due to cumulative impacts on cultural resources and tribal values and concerns, as development, mining, and disturbance of the natural landscape cumulatively impact the cultural heritage of these communities.

- *Pinto Valley Mine Expansion.* The Pinto Valley Mine is an existing open-pit copper and molybdenum mine located approximately 8 miles west of Miami, Arizona, in Gila County. Pinto Valley Mining Corporation is proposing to expand mining activities onto the Tonto National Forest and extend the life of the mine to 2039. EIS impact analysis is pending. Proposed expansion and continuation of operations at the Pinto Valley Mine may negatively and disproportionally affect environmental justice communities by decreasing available housing and/or driving up costs of affordable housing associated with a relatively sudden influx of workers. Activity at the Pinto Valley Mine, in combination with other mining in the Globe-Miami-Superior-Kearny-Hayden area, may contribute to this well-documented phenomenon.
- *Ray Land Exchange and Proposed Plan Amendment.* ASARCO is also seeking to complete a land exchange with the BLM by which the mining company would gain title to approximately 10,976 acres of public lands and federally owned mineral estate located near ASARCO's Ray Mine in exchange for transferring to the BLM approximately 7,304 acres of private lands, primarily in northwestern Arizona. It is known that at some point ASARCO wishes to develop a mining operation in the "Copper Butte" area west of the Ray Mine. Under the proposed land exchange, Executive Order 12898 would no longer apply to the selected lands, and the offered lands would comply with Executive Order 12898. Development of these lands could have the potential to disproportionately affect low-income and/or minority populations by increasing pressures on local infrastructure such as roads, schools, medical services, and the availability and affordability of housing in the towns of Superior, Hayden, and Winkelman. Large-scale mining projects such as the Resolution Copper Mine and the mining developments described here may also alter rural settings and lifestyles experienced by protected populations.
- *Ripsey Wash Tailings Project.* Mining company ASARCO is planning to construct a new tailings storage facility to support its Ray Mine operations. As approved, the proposed tailings storage facility project would occupy 2,627 acres of private lands and 9 acres of BLM lands and be situated within the Ripsey Wash watershed just south of the Gila River approximately 5 miles west-northwest of Kearny, Arizona, and would contain up to 750 million tons of material (tailings and embankment material). The tailings facility would include two starter dams, new pipelines to transport tailings and reclaimed water, a pumping booster station, a containment pond, a pipeline bridge across the Gila River, and other supporting infrastructure. ASARCO estimates a construction period of 3 years and approximately 50 years of expansion of the footprint of the tailings storage facility as slurry tailings are added to the facility, followed by a 7- to 10-year period for reclamation and final closure. A segment of the Arizona Trail would be relocated east of the tailings storage facility. Development of these lands could have the potential to disproportionately affect low-income and/or minority populations by increasing pressures on local infrastructure such as roads, schools, medical services, and the availability and affordability of housing in the towns of Superior, Hayden, and Winkelman. Large-scale mining projects such as the Resolution Copper Mine and the mining developments described here may also alter rural settings and lifestyles experienced by protected populations.

These projects could potentially contribute to effects on low-income or minority populations through the projected life of the Resolution Copper Mine (50–55 years).

3.15.4.8 Mitigation Effectiveness

The Forest Service is in the process of developing a robust mitigation plan to avoid, minimize, rectify, reduce, or compensate for resource impacts that have been identified during the process of preparing this EIS. Appendix J contains descriptions of mitigation concepts being considered and known to be effective, as of publication of the DEIS. Appendix J also contains descriptions of monitoring that would be needed to identify potential impacts and mitigation effectiveness. As noted in chapter 2 (section 2.3), the full suite of mitigation would be contained in the FEIS, required by the ROD, and ultimately included in the final GPO approved by the Forest Service. Public comment on the DEIS, and in particular appendix J, will inform the final suite of mitigations.

At this time, no mitigation measures have been identified that would be solely pertinent to environmental justice, though a number of measures have been identified for other resources. Applicant-committed environmental protection measures have already been detailed elsewhere in this section, will be a requirement for the project, and have already been incorporated into the analysis of impacts.

Unavoidable Adverse Impacts

The change in scenery and dark skies for the town of Superior cannot be avoided or fully mitigated. Similarly, the disproportionately high and adverse impacts on cultural resources and tribal values and concerns cannot be avoided or fully mitigated.

3.15.4.9 Other Required Disclosures

Short-Term Uses and Long-Term Productivity

Environmental justice impacts are expected only for the town of Superior, and tribes with cultural, social, or religious ties to the project area would be affected permanently from direct, permanent impacts on these sites and values. The loss of these values would be long term.

Irreversible and Irretrievable Commitment of Resources

There would be irretrievable socioeconomic impacts under all action alternatives because existing land uses, including recreation opportunities, would be precluded within the project area during the life of the project. All action alternatives would potentially cause irreversible impacts on the affected area with regard to changes in the local landscape, infrastructure and tax base funding, community values, and quality of life for residents of the town of Superior.

Overview

The Resolution Copper Mine project area and alternative tailings locations comprise public lands under both Federal and State jurisdiction as well as privately owned lands. Federal lands are managed by the Forest Service and the BLM, while State Trust lands are under the stewardship of the ASLD. As described in the sections that follow, approval of either the GPO-proposed mine or any of the alternatives presented in this EIS would result in the loss to public use of substantial areas of Federal and State lands, including recreational use, livestock grazing, and other uses. Some roads, fencing, range improvements, boundary markers, and other existing features would be permanently eliminated or altered.

3.16 Livestock and Grazing

3.16.1 Introduction

There are currently 17 established grazing allotments totaling approximately 462,000 acres within the analysis area on lands managed either by the Forest Service, BLM, or ASLD, or on privately owned lands. Most allotments are some combination of land management and/or ownership, where multiple grazing permits are held by a single permittee for the allotment.

Within the analysis area, all action alternatives would affect vegetation and/or water sources and cause direct or indirect impacts that would render portions of the current grazing allotments unavailable for livestock grazing. Impacts are expected throughout the full life cycle of the mine, including construction, operations, closure and reclamation, and post-closure phases.

3.16.2 Analysis Methodology, Assumptions, Uncertain and Unknown Information

3.16.2.1 Analysis Area

The analysis area for livestock and grazing includes the entirety of all allotments that overlap spatially, in full or in part, with the primary GPO-proposed mine components (East Plant Site and subsidence area, West Plant Site, MARRCO corridor, filter plant and loadout facility, Near West tailings storage facility and pipeline corridors, and transmission lines) and each alternative tailings storage facility analyzed in this EIS (figure 3.16.2-1). Temporal analysis of impacts on livestock and grazing includes all portions of grazing allotments over the period in which mine activities could occur (50–55 years), including the construction, operations, closure and reclamation, and post-closure phases.

3.16.2.2 Methodology

This analysis documents the potential for acreages of grazing allotments to change, the potential for animal unit months (AUMs)[72] to be reduced, and the potential for loss of grazing-related facilities (e.g., stock watering sources). Grazing allotments intersecting with the analysis area were identified through geospatial data obtained from the Tonto National Forest, BLM, and ASLD. Where necessary, the datasets were reconciled to one another and to available geospatial land ownership data, in order to make data from the different sources comparable for analysis. The total acreages of each allotment and the acres potentially impacted by project-related activities were then determined through geographic information system (GIS) spatial analysis. AUM values were calculated based on the original AUMs per acre of the entire allotment and were extrapolated to the anticipated acreage of impact to yield a proportional estimate of reduction in AUMs (e.g., 100 AUMs are allowed on a 1,000-acre allotment; if reduced by 500 acres, the available AUMs become 50). Data on ownership, lease agreements, AUMs, etc., were identified and evaluated where available.

72. An “animal unit month” metric used to identify the amount of forage required to feed one mature cow weighing approximately 1,000 pounds and a calf up to weaning age.

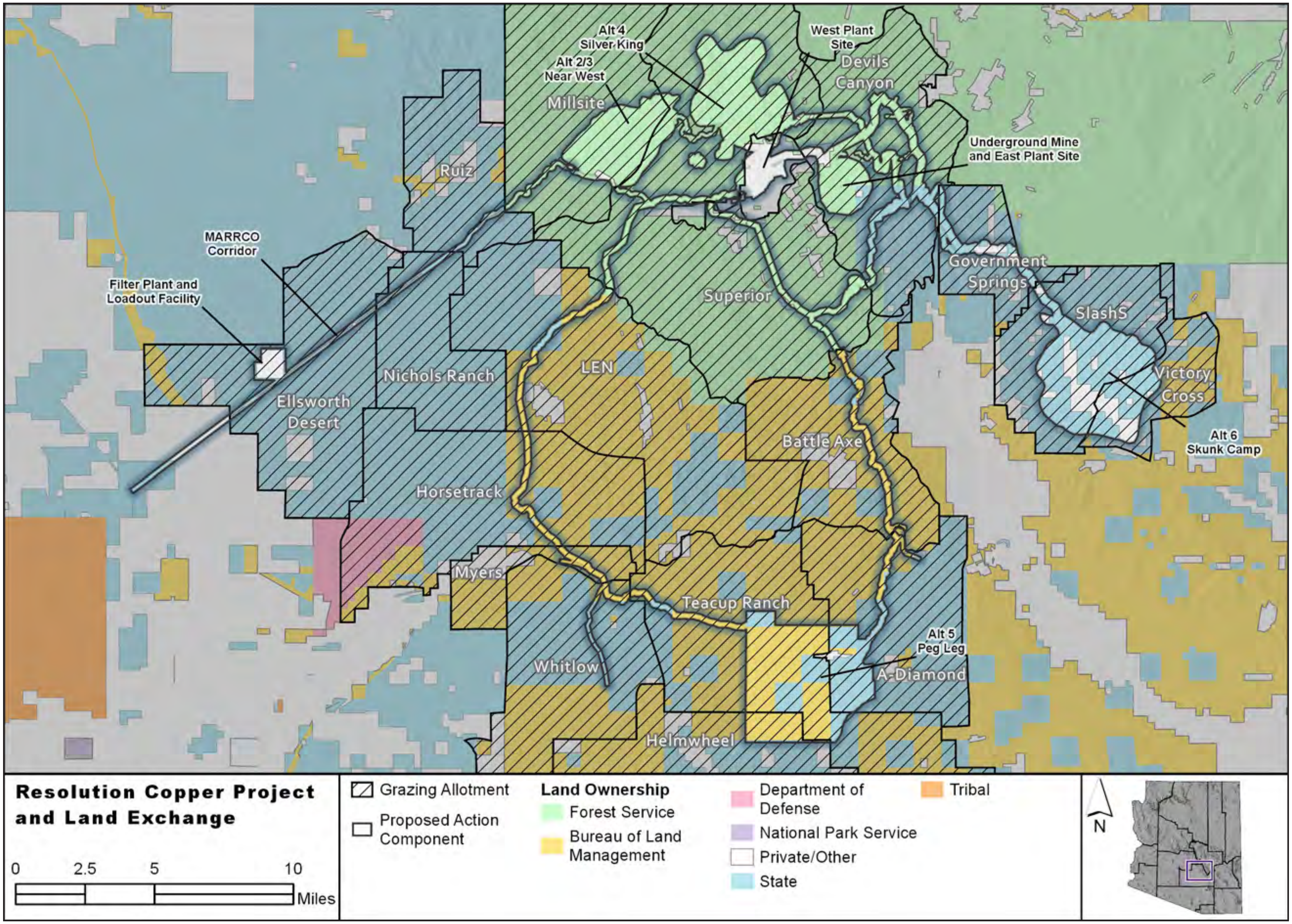


Figure 3.16.2-1. Analysis area for evaluating existing rangeland conditions and livestock grazing allotments

Primary Legal Authorities Relevant to the Livestock and Grazing Effects Analysis

- Taylor Grazing Act of 1934
- Federal Land Policy and Management Act of 1976
- Multiple-Use Sustained-Yield Act of 1960
- Tonto National Forest Land and Resource Management Plan
- Forest and Rangeland Renewable Resources Planning Act of 1974

Impacts on springs, as well as livestock and wildlife water sources, were identified by evaluation of publicly available geospatial data retrieved from several sources: Tonto National Forest, BLM Tucson Field Office, and AGFD, as well as various environmental resource surveys prepared under contract for Resolution Copper. Data on existing rangeland conditions, where available, were taken from environmental assessments and allotment management plans, but range conditions have not been recorded for most grazing allotments in the analysis area.

It should be noted that the water sources described as being lost in this section may differ from the groundwater-dependent ecosystems that are described as being impacted in section 3.7.1, but for which mitigation is anticipated to maintain or replace the water sources described in this analysis. Section 3.7.1 focuses on GDEs with persistent, perennial water tied to regional aquifers. This section focuses on water for wildlife from a variety of sources, including tanks and springs that would be directly impacted and may rely on temporary or seasonal sources of water. In addition, some impacts on livestock access from fencing may not be considered in section 3.7.1, which focuses on direct disturbance instead of loss of access.

3.16.3 Affected Environment

3.16.3.1 Relevant Laws, Regulations, Policies, and Plans

A complete listing and brief description of the legal authorities, reference documents, and agency guidance used in this livestock and grazing analysis may be reviewed in Newell (2018c).

3.16.3.2 Existing Conditions and Ongoing Trends

There are currently 17 established grazing allotments totaling approximately 462,000 acres in the analysis area. The proposed action and its alternatives intersect only about 10 percent of these allotments by area. This section summarizes existing conditions for the entirety of each allotment to the extent that existing conditions can be described.

Because of their relatively large and complex geographic areas, each grazing allotment is of varying size and varying land management; however, allotments are typically leased by a single entity that must obtain grazing rights (a permit or authorization) from each respective land manager/owner.

Rangelands in the analysis area are typically Sonoran desertscrub dominated by large cacti and tall shrubs at lower elevations (below 3,500 feet) and are chaparral dominated by dense shrub species such as oak, manzanita, and mountain mahogany above 4,000 feet. Semi-arid grasslands predominate in the transition zone between these type primary ecozones (Arizona Roadside Environments 1999).

Given the complex relationship between livestock grazing and land management, allotments are discussed in this section by land-managing agency. The level of detail provided is based on available data.

Table 3.16.3-1. Acreages of Forest Service livestock grazing leases by allotment

Allotment Name	Grazing Lease Acreage*	Livestock Type / Number	Recommended AUMs
Devil's Canyon	18,700	Cattle / 200	1,104
Millsite	44,483	Cattle / 307	4,374
Superior	56,141	Cattle / 314	5,300

Source: Livestock type/number and AUMs were taken from the Forest Service livestock grazing records.

* Acreages are estimates based on available spatial data.

Forest Service Grazing Allotments

The Forest Service manages grazing permits within three allotments in the analysis area: Devil's Canyon (18,700 acres), Millsite (44,483 acres), and Superior (56,141 acres), for a total of approximately 119,323 acres of permitted grazing on NFS lands (table 3.16.3-1). Permitted grazing uses for Forest Service grazing allotments are summarized in this section. Actual use may be less than permitted use, mainly as a result of periods of extended drought (U.S. Forest Service 2010d).

DEVIL'S CANYON ALLOTMENT

The grazing permit for the portion of the Devil's Canyon Allotment on NFS land is held by Integrity Land and Cattle, of which Resolution Copper is a principal owner. Integrity Land and Cattle operates JI Ranch and runs approximately 200 head of cattle on this allotment as of the GPO (2016d). The carrying capacity for this allotment is 1,104 AUMs.

MILLSITE ALLOTMENT

The grazing permit for the portion of the Millsite Allotment on NFS land is held by William and Lynn Martin. William and Lynn Martin own JF Ranch and are permitted to graze 307 cows/bulls year-round and 197 yearlings between January 1 and May 31. In 1983, a production-utilization study showed 36,806 acres of the Millsite Allotment as being at full-capacity range; the remaining 6,815 acres were identified as having no capacity. As of 1983, the lessees of the Millsite Allotment were using 17,359 of the full-capacity range acreage for livestock use, or 47.7 percent of available rangeland (U.S. Forest Service 2010d). The 1983 study also estimated that, with improved management, capacity for the Millsite Allotment is 4,374 AUMs.

Table 3.16.3-2. Vegetation condition rating, Millsite Allotment, 1991–2003

Cluster Number	Pasture	Vegetation Rating and Trend
C1	Cottonwood	Very poor, stable
C2	Woodbury	Fair, stable
C3	Bear Tank	Poor, stable
C4	Millsite	Poor, downward
C5	Millsite	Poor, downward
C6	Hewitt	Fair, downward
C7	Cottonwood	Poor, stable

Source: U.S. Forest Service (2010d)

Note: Rating system given on a scale from "Poor" to "Excellent."

Sonoran desertscrub covers approximately 75 to 80 percent of the Millsite Allotment and has been heavily impacted by the area's history of livestock grazing. An analysis was performed on data collected between 1991 and 2003 at seven sample clusters in the allotment to create a vegetation condition rating (U.S. Forest Service 2010d). Overall, vegetation conditions on the allotment were poor, and nearly one-half are deteriorating (table 3.16.3-2). As a result, the Forest Service prescribed a deferred and/or rest rotation method for the Millsite Allotment Management Plan (U.S. Forest Service 2016c). Soil conditions for the allotment were evaluated in 2004, 2008, and 2009, and are shown in table 3.16.3-3.

Table 3.16.3-3. Soil condition in acres, Millsite Allotment

Condition	Acres*	Relative Percentage
Satisfactory	34,763	78
Impaired	3,565	8
Unsatisfactory-Impaired	446	1
Unsatisfactory	5,794	13
Total	**44,568**	**100**

Source: U.S. Forest Service (2010d)

Notes: The soil rating system is based on the Natural Resources Conservation Service Soil Condition Rating Guide. These ratings are defined as follows (U.S. Forest Service 1999):

Satisfactory – Indicators signify that soil function is being sustained and soil is functioning properly and normally. The ability of soil to maintain resource values and sustain outputs is high.

Impaired – Indicators signify a reduction in soil function. The ability of soil to function properly has been reduced and/or there exists an increased vulnerability to degradation.

Unsatisfactory – Indicators signify that loss of soil function has occurred. Degradation of vital soil functions results in the inability of soil to maintain resource values, sustain outputs, and recover from impacts.

* Acreages are estimates based on available spatial data.

SUPERIOR ALLOTMENT

The grazing permit for the portion of the Superior Allotment on NFS land is held by DNH Cattle Company, which is permitted to graze 314 cows/bulls throughout the year and 174 yearlings between January 1 and May 31. Most full-capacity range within this allotment is located at higher elevations. In 1961, an allotment analysis determined the carrying capacity to be 5,300 AUMs (U.S. Forest Service no date). The soil and vegetation conditions on the Superior Allotment are considered poor, especially at low elevations, resulting from improper grazing in the past, with irreversible effects in some areas. The current management practice of a 6-month pasture/6-month rest rotation schedule, outlined in the Superior Allotment management plan, intends to provide extended rest to the stressed lowland areas and allow spring/summer rest for two consecutive years out of three (U.S. Forest Service 2016c). A summary of the Superior Allotment's 2018 authorized use is presented in table 3.16.3-4 (U.S. Forest Service no date).

Table 3.16.3-4. Authorized use for Superior Allotment, 2018, DNH Cattle Company

Grazing Unit	Dates of Use	Monitoring Date	Authorized Livestock
North Side			
Montana	11/1/2017 to 4/30/2018	3/27/2018	180 cow/calf 14 bulls 22 yearlings
Silver Canyon	5/1/2018 to 10/30/2018	8/21/2018	180 cow/calf 14 bulls
88	11/1/2018 to 4/30/2019	3/14/2019	180 cow/calf 14 bulls
Silver Canyon, 88 Deferred for 2018			
South Side			
Town, North TU	3/1/2018 to 5/1/2018	4/26/2018	101 cow/calf 24 yearlings
Wildhorse	3/1/2018 to 5/10/2018	5/17/2018	5 bulls
TU Trap, Holding	5/2/2018 to 5/10/2018	5/17/2018	101 cow/calf 24 yearlings
South TU	5/10/2018 to 10/1/2018	8/23/2018	101 cow/calf 6 bulls
Town, North TU	10/2/2018 to 2/28/2019	1/29/2019	101 cow/calf 6 bulls

Source: Sando (2018)
Note: No pastures rested or deferred during 2018.

Each individual allotment management plan outlines a monitoring program with the intent of determining whether the currently prescribed management practices are properly implemented and effective for the improvement of rangeland conditions. The Tonto National Forest implements compliance monitoring to ensure livestock are distributed correctly, and to inspect improvements and maintenance, and forage utilization, among other variables, with an inspection scheduled each grazing year. Other monitored aspects are the presence of noxious weeds and riparian conditions, which may be monitored on longer time intervals (5–10 years) as needed (U.S. Forest Service 2016c). Monitoring practices may be modified if there are significant changes to livestock use patterns.

Bureau of Land Management Grazing Allotments

The BLM authorizes grazing permits within nine allotments in the analysis area totaling about 17,855 acres (see table 3.16.3-4). Detailed grazing conditions and documentation for most of these grazing permits are not available; however, the NEPA process for the Teacup and Whitlow Allotments were initiated in 2017 (Bureau of Land Management 2017a). The Land Health Evaluation for the Teacup and Whitlow grazing leases indicated that the general range conditions met the standards set for them by the BLM. BLM also suggested that Teacup could support 392 cattle under 3,058 AUMs, while Whitlow could support 136 cattle under 588 AUMs. BLM's Rangeland Administration System data were queried for acreage and AUMs for the remaining BLM grazing leases. Table 3.16.3-5 provides acreages for the grazing permits that BLM manages in the analysis area, the number of livestock, and recommended AUMs.

Table 3.16.3-5. Acreages for BLM livestock grazing leases by allotment

Allotment Name	Grazing Lease Acreage*	Livestock Type / Number	Recommended AUMs
LEN	23,742	Cattle / 357	2,964
Teacup	28,794	Cattle / 392	3,058
Helmwheel	14,856	Cattle / 119	1,428
A-Diamond	6,580	Cattle / 301	686
Victory Cross	2,862	Cattle / 163	411
Battle Axe	14,822	Cattle / 210	1,562
Horsetrack	11,218	Cattle / 102	1,224
Meyers	4,618	Cattle / 47	564
Whitlow	10,363	Cattle / 136	588

Source: Livestock type/number and AUMs were taken from the BLM Rangeland Administration System (Bureau of Land Management 2019)
* Acreages are estimates based on available spatial data.

Arizona State Land Department Grazing Leases

The ASLD manages grazing permits within 14 allotments in the analysis area totaling 152,042 acres. ASLD does not maintain detailed documentation on rangeland conditions for specific grazing permit areas; however, this analysis assumes that rangeland conditions for State Trust lands would be similar to those found on neighboring NFS and BLM lands. Rangeland data summarized in table 3.16.3-6 were taken from the Arizona Land Resources Information System (ALRIS), a spatial data viewer maintained by the ASLD.

Table 3.16.3-6. Acreages for ASLD grazing leases by allotment

Allotment Name	Grazing Lease Acreage*	Recommended AUMs
LEN	14,328	1,346
Teacup	12,098	1,583
Helmwheel	30,622	2,843
A-Diamond	2,441	955
Victory Cross	4,476	1,048
Battle Axe	3,270	425
Horsetrack	16,842	1,414
Whitlow	11,275	1,066
Devil's Canyon	6,605	1,104
Ellsworth Desert	6,379	2,250
Ruiz	11,561	1,246
Slash S	15,351	5,757
Nichols Ranch	11,561	1,300
Government Springs	7,233	924

Source: AUMs were taken from Arizona Land Resources Information System (Arizona State Land Department 2019a)
* Acreages are estimates based on available spatial data.

3.16.4 Environmental Consequences of Implementation of the Proposed Mine Plan and Alternatives

3.16.4.1 Alternative 1 – No Action Alternative

Under the no action alternative, no alterations would be made to current grazing access or allotments, nor would there be any direct loss of stock tanks, seeps, and springs. However, six springs in the Superior Allotment are anticipated to be impacted by continued dewatering pumping of mine infrastructure. Management would continue as outlined per the allotment management plans and rangeland conditions would improve or deteriorate contingent upon the plans' effectiveness, combined with the mounting effects of climate change. Climate change is expected to result in droughts that are more frequent and of longer duration, which could stress vegetation and require adjustments to allotment management plans in the future.

3.16.4.2 Impacts Common to All Action Alternatives

Impacts on Allotments

All action alternatives would result in direct and indirect impacts on livestock and grazing within the analysis area because all areas within project facility footprints would become inaccessible to grazing. Impacts are expected throughout the full life cycle of the mine, including the construction, operations, closure and reclamation, and post-closure phases. Direct impacts of any action alternatives include the following:

- Reduction in acreage of grazing allotments
- Reduction in available AUMs within individual grazing allotments
- Loss of grazing-related facilities (water sources or infrastructure)

All action alternatives would see impacts on grazing allotments located in the East Plant Site, subsidence area, and MARRCO corridor. An area within the East Plant Site and Oak Flat Federal Parcel would be fenced off at the commencement of the construction phase of the mine, and the perimeter would be extended every 10 years following the start of operations to account for the additional area impacted by subsidence. Presently, there is no plan to make the area within the subsidence area accessible after Resolution Copper has ownership of the parcel (Resolution Copper 2016d); this would result in a reduction of at least 1,856 acres in the Devil's Canyon Allotment and a direct impact on Integrity Land and Cattle, which currently owns the grazing permit on that allotment. In addition, all action alternatives would see a reduction of at least 38 acres on the Millsite Allotment and some reduction in acreage on the Superior Allotment, although the amount varies by alternative. Implementation of any action alternative would result in loss of the livestock water sources identified in table 3.16.4-1.

Effects of Reclamation

The tailings storage facility represents a large area of disturbance (approximately 2,300 to approximately 5,900 acres, depending on the selected tailings storage facility location) that would be reclaimed after closure. The success of reclamation and the ability to reestablish vegetation on the tailings storage facility surface would have a large effect on the ability to sustain livestock grazing as a post-mine land use. Potential reclamation success is analyzed in detail in section 3.3. Overall, in areas where ground disturbance is relatively low, and soil resources (e.g., nutrients, organic matter, microbial communities) and vegetation propagules (e.g., seedbank or root systems to resprout) remain relatively intact, it would be expected that vegetation communities could rebound to similar pre-disturbance conditions in a matter of decades to centuries. In contrast, for the tailings storage facility, which would be covered in non-soil capping material (such as Gila Conglomerate), biodiversity and ecosystem function may never reach the original, pre-disturbance conditions even after centuries of recovery. Allowing grazing as a post-mine land use would need to be weighed against the potential sustainability of the soil and vegetation ecosystem.

Table 3.16.4-1. Livestock water sources impacted under all action alternatives

Name	Type	Nearest Project Area	Grazing Allotment
Ranch Rio Spring	Spring	Subsidence area	Devil's Canyon
The Grotto	Spring	Subsidence area	Devil's Canyon
Apache Leap Stock Tank	Dugout/pit tank	East Plant Site	Devil's Canyon
Oak Flat Stock Tank	Dugout/pit tank	Subsidence area	Devil's Canyon
Reservoir Tank 2	Stock tank, intermittent	Subsidence area	Devil's Canyon
No Name	Tanks	MARRCO corridor	Millsite
Bitter Spring	Spring	Dewatered by pumping	Superior
Bored Spring	Spring	Dewatered by pumping	Superior
Hidden Spring	Spring	Dewatered by pumping	Superior
McGinnel Spring	Spring	Dewatered by pumping	Superior
McGinnel Mine Spring	Spring	Dewatered by pumping	Superior
Walker Spring	Spring	Dewatered by pumping	Superior
DC-6.6W	Spring	Dewatered by pumping	Devil's Canyon
Kane Spring	Spring	Dewatered by pumping	Devil's Canyon

Sources: WestLand Resources Inc. and Montgomery and Associates Inc. (2018); WestLand Resources Inc. (2018d)

Effects of the Land Exchange

The selected Oak Flat Federal Parcel would leave Forest Service jurisdiction, and approximately 1,856 acres of the existing Devil's Canyon Allotment on Tonto National Forest lands (presently permitted to Integrity Land and Cattle Company) would become unavailable for grazing, resulting in an overall reduction of available AUMs. This is an approximately 7 percent loss in total size of the grazing allotment.

The offered lands parcels would come under Federal jurisdiction. The Forest Service supports livestock grazing as a valuable resource to promote on the landscape, provided that it is responsibly performed and managed and does not injure plant growth. BLM's rangeland program places an emphasis in multi-jurisdictional ecosystem management in Arizona. This involves interdisciplinary resource management in consultation and coordination with other Federal, State, and local agencies and Indian Tribes. The specific management of livestock and grazing on the offered lands would be determined by the agencies upon transference of the parcels, but in general, when the offered lands enter Federal jurisdiction, the parcels would have the potential to be permitted for grazing where there currently is none. The Apache Leap South End Parcel would be exempt from grazing as it would become part of a management area that has no new grazing allowed. Allotments on the Forest Service that surround some of the offered lands parcels include Cartwright, Red Creek, and Tonto Basin, among others. Allotments managed by the BLM that surround some of the offered lands parcels are Dripping Springs and Steamboat Mountain.

Forest Plan Amendment

The Tonto National Forest Land and Resource Management Plan (1985b) provides guidance for management of lands and activities within the Tonto National Forest. It accomplishes this by establishing a mission, goals, objectives, and standards and guidelines. Missions, goals, and objectives are applicable on a forest-wide basis. Standards and guidelines are either applicable on a forest-wide basis or by specific management area.

A review of all components of the 1985 forest plan was conducted to identify the need for amendment due to the effects of the project, including both the land exchange and the proposed mine plan (Shin 2019). A number of standards and guidelines (13) were identified as applicable to livestock grazing. None of these standards and guidelines were found to require amendment to the proposed project, on either a forest-wide or management area-specific basis. For additional details on specific rationale, see process memorandum Shin (2019).

SUMMARY OF APPLICANT-COMMITTED ENVIRONMENTAL PROTECTION MEASURES

No environmental protection measures were identified as being incorporated into the design of the project that would act to reduce potential impacts on livestock grazing. However, note that a number of measures meant to reduce impacts on water resources could be applicable to livestock grazing as well. These are described primarily in sections 3.7.1 and 3.7.3.

3.16.4.3 Alternative 2 – Near West Proposed Action

Implementation of this alterative would result in the reduction of available grazing within six allotments under various management or ownership. Table 3.16.4-2 summarizes the anticipated reduction in acres of land available for livestock grazing from this alternative by allotment and by land manager/owner, and reductions in AUMs by allotment are estimated where data were available.

Under Alternative 2, approximately 8,572 acres of land currently authorized for livestock grazing use would be forfeited, with the greatest impacts occurring on the Devil's Canyon and Millsite Allotments, with relatively lesser impacts on the Ellsworth Desert and Superior Allotments, and minor impacts on the Nichols Ranch and Ruiz Allotments.

Implementation of Alternative 2 would also result in the loss of access to four or five natural springs, as well as five or six constructed stock watering and/or wildlife watering features (table 3.16.4-3).

Table 3.16.4-2. Reduction in available grazing by allotment and ownership – Alternative 2

Grazing Allotment	Private (acres)	NFS (acres) / AUMs	ASLD (acres) / AUMs	Total Grazing Reduction (acres)
Devil's Canyon	237	1,990 / 117	145 / 24	**2,372**
Ellsworth Desert	668	0	46 / 4	**714**
Millsite	65	4,196 / 413	0	**4,261**
Nichols Ranch	47	0	36 / 3	**83**
Ruiz	29	0	45 / 5	**74**
Superior	3	1,065 / 100	0	**1,068**
Total				**8,572**

3.16.4.4 Alternative 3 – Near West – Ultrathickened

Implementation of Alternative 3 would result in the same impacts on lands currently authorized for livestock grazing and water sources use and access as described for Alternative 2.

Table 3.16.4-3. Water sources impacted under Alternative 2

Name	Type	Nearest Project Area	Grazing Allotment
Bear Tank Canyon Spring	Spring	Tailings facility	Millsite
Benson Spring	Spring	Tailings facility	Millsite
Lower Bear Tank Canyon Spring	Spring	Tailings facility	Millsite
Perlite Spring	Spring	Tailings facility	Superior
Benson Spring	Unknown	Tailings facility	Millsite
Hackberry Tank	Dugout/pit tank	Tailings facility	Millsite
Noble Windmill	Windmill/well	Tailings facility	Millsite
Pilot Tank	Dugout/pit tank	Tailings facility	Millsite
No Name	Spring, trough	Tailings facility	Millsite
No Name	Well	Tailings facility	Millsite
Conley Spring	Spring	Tailings facility	Millsite

Sources: WestLand Resources Inc. and Montgomery and Associates Inc. (2018); WestLand Resources Inc. (2018d)

Table 3.16.4-4. Reduction in available grazing by allotment and ownership – Alternative 4

Grazing Allotment	Private (acres)	NFS (acres) / AUMs	ASLD (acres) / AUMs	Total Grazing Reduction (acres)
Devil's Canyon	237	1,990 / 117	277 / 46	**2,504**
Ellsworth Desert	668	0	46 / 4	**714**
Millsite	17	112 / 11	0	**129**
Nichols Ranch	47	0	36 / 3	**83**
Ruiz	29	0	45 / 5	**74**
Superior	52	5,843 / 551	0	**5,895**
Total				**9,399**

3.16.4.5 Alternative 4 – Silver King

Implementation of the Silver King alternative would result in reduction of available grazing within six allotments under various management or ownership. Table 3.16.4-4 summarizes the anticipated reduction in acres of land available for livestock grazing from this alternative by allotment and by land manager/owner, and reductions in AUMs by allotment are estimated where data were available. Implementation of Alternative 4 would also result in the loss of access to springs and other livestock and/or wildlife water sources (see table 3.16.4-4).

Under Alternative 4, approximately 9,399 acres of land currently authorized for livestock grazing would be forfeited, with the greatest impacts occurring on the Superior Allotment. Relatively moderate impacts would occur on the Devil's Canyon Allotment, with more minor impacts occurring on the Ellsworth Desert, Millsite, Nichols Ranch, and Ruiz Allotments.

Table 3.16.4-5. Water sources impacted under Alternative 4

Name	Type	Nearest Project Area	Grazing Allotment
McGinnel Mine Spring	Spring	Fence line (note this spring is already impacted by pumping)	Superior
Mud Spring 2	Spring	Fence line	Superior
Rock Horizontal Spring	Spring	Fence line	Superior
Iberri Spring	Spring	Tailings facility	Superior
McGinnel Spring	Spring	Tailings facility	Superior
Cedar Tank	Stock tank, intermittent	Fence line	Superior
Comet Tank	Stock tank, intermittent	Tailings facility	Superior
Dugan Tank	Stock tank, intermittent	Fence line	Superior
Javelina Tank	Stock tank, intermittent	Fence line	Superior
Peachville Tank	Stock tank, intermittent	Fence line	Superior
No Name	Well	Fence line	Superior

Sources: WestLand Resources Inc. and Montgomery and Associates Inc. (2018); WestLand Resources Inc. (2018d)

Implementation of Alternative 4 would also result in the loss of access to five natural springs, as well as six constructed stock watering and/or wildlife watering features (table 3.16.4-5).

3.16.4.6 Alternative 5 – Peg Leg

The Peg Leg alternative would include an east route pipeline option and a west route pipeline option. Implementation of the Peg Leg east pipeline option would result in the reduction of available grazing within 10 grazing allotments, while the Peg Leg west pipeline option would affect 13 grazing allotments. Table 3.16.4-6 summarizes the anticipated reduction in acres of land available for livestock grazing from this alternative by allotment and by land manager/owner, as well as by pipeline route, and reductions in AUMs by allotment are estimated where data were available.

Under the east pipeline option for Alternative 5, approximately 15,672 acres of land currently authorized for livestock grazing would be forfeited over 10 allotments, with the greatest impacts occurring on the Teacup Allotment. Slightly fewer acres on each of the Devil's Canyon, A-Diamond, and Helmwheel Allotments would be affected, with relatively lesser impacts on the remaining allotments.

Under the west pipeline option for Alternative 5, approximately 16,186 acres of land currently authorized for livestock grazing would be forfeited over 13 allotments, with the greatest impacts occurring on the Teacup Allotment. Slightly fewer acres on each of the A-Diamond, Devil's Canyon, and Helmwheel Allotments would be affected, with relatively lesser impacts on the remaining allotments.

Implementation of the Peg Leg alternative would result in the loss of access to natural springs, as well as constructed stock watering and/or wildlife watering features, but none outside those shown in impacts common to all (see table 3.16.4-1).

Constructed stock watering and/or wildlife water facilities in the tailings pipeline corridor options could be present yet are not listed. It is expected that the water source would be avoided during micro-siting or would be replaced as per water resources mitigation. Impacts associated with water sources in the tailings pipeline corridor options would be associated with construction and therefore would be short term and temporary.

Table 3.16.4-6. Reduction in available grazing by allotment, ownership, and pipeline route – Alternative 5

Grazing Allotment	Private (acres)	NFS (acres) / AUMs	ASLD (acres) / AUMs	BLM (acres) / AUMs	Total Grazing Reduction (acres)
EAST PIPELINE OPTION					
A-Diamond	144	0	2,440 / 155	188 / 20	**2,772**
Battle Axe	6	0	31 / 4	416 / 44	**453**
Devil's Canyon	237	1,990 / 117	278 / 46	0	**2,505**
Ellsworth Desert	668	0	46 / 4	0	**714**
Helmwheel	4	0	16 / 1	1,271 / 122	**1,291**
Millsite	17	112 / 11	0	0	**129**
Nichols Ranch	47	0	36 / 3	0	**83**
Ruiz	29	0	45 / 5	0	**74**
Superior	24	710 / 67	0	0	**734**
Teacup	3	0	1,830 / 239	5,084 / 540	**6,917**
Total					**15,672**
WEST PIPELINE OPTION					
A-Diamond	129	0	2,306 / 146	129 / 14	**2,564**
Devil's Canyon	237	1,990 / 117	278 / 46	0	**2,505**
Ellsworth Desert	668	0	46 / 4	0	**714**
Helmwheel	4	0	16 / 1	1,271 / 244	**1,291**
Horsetrack	0	0	6 / 1	311 / 34	**317**
LEN	0	36 / 3	88 / 8	325 / 40	**449**
Millsite	17	112 / 11	0	0	**129**
Meyers	0	0	0	138 / 17	**138**
Nichols Ranch	47	0	36 / 3	0	**83**
Ruiz	29	0	45 / 5	0	**74**

continued

Table 3.16.4-6. Reduction in available grazing by allotment, ownership, and pipeline route – Alternative 5 *(cont'd)*

EAST PIPELINE OPTION					
Superior	8	597 / 56	0	0	**605**
Teacup	3	0	1,893 / 495	5,311 / 1,128	**7,207**
Whitlow	0	0	20 / 2	90 / 5	**110**
Total					**16,186**

3.16.4.7 Alternative 6 – Skunk Camp

The Skunk Camp alternative would include a north route pipeline option and a south route pipeline option. Implementation of either pipeline route option would result in reduced grazing opportunities within the same nine grazing allotments, but with variable acres impacted. Table 3.16.4-7 summarizes the anticipated reduction in available grazing from this alternative by allotment and by land manager/owner, as well as by pipeline route, and reductions in AUMs by allotment are estimated where data were available.

Under the north pipeline option for Alternative 6, approximately 14,747 acres of existing livestock grazing would be lost over nine allotments, with the largest grazing impacts occurring on the Slash S Allotment. Slightly fewer acres on each of the Devil's Canyon and Victory Cross Allotments would be affected, with relatively minor impacts on the remaining allotments.

Under the south pipeline option for Alternative 6, approximately 15,209 acres of existing livestock grazing would be lost over nine allotments, with the largest grazing impacts occurring on the Slash S Allotment. Slightly fewer acres on each of the Devil's Canyon and Victory Cross Allotments would be affected, with relatively minor impacts on the remaining allotments.

Implementation of the Skunk Camp alternative would result in the loss of access to natural springs, as well as constructed stock watering and/or wildlife watering features (table 3.16.4-8).

Table 3.16.4-7. Reduction in available grazing by allotment, ownership, and pipeline route – Alternative 6

Grazing Allotment	Private (acres)	NFS (acres) / AUMs	ASLD (acres) / AUMs	BLM (acres) / AUMs	Total Grazing Reduction (acres)
NORTH PIPELINE OPTION					
Devil's Canyon	237	2,860 / 169	627 / 105	0	**3,724**
Ellsworth Desert	668	0	46 / 4	0	**714**
Government Springs	269	0	599 / 77	0	**868**
Millsite	17	112 / 11	0	0	**129**
Nichols Ranch	47	0	36 / 3	0	**83**
Ruiz	29	0	45 / 5	0	**74**
Slash S	1,333	0	5,050 / 1,894	0	**6,383**
Superior	13	319 / 30	0	0	**332**
Victory Cross	833	0	1,607 / 376	0	**2,440**
Total					**14,747**
SOUTH PIPELINE OPTION					
Devil's Canyon	237	2,520 / 149	853 / 143	0	**3,610**
Ellsworth Desert	668	0	46 / 4	0	**714**
Government Springs	269	0	599 / 77	0	**868**
Millsite	17	112 / 11	0	0	**129**
Nichols Ranch	47	0	36 / 3	0	**83**
Ruiz	29	0	45 / 5	0	**74**
Slash S	1,333	0	5,050 / 1894	0	**6,383**

continued

Table 3.16.4-7. Reduction in available grazing by allotment, ownership, and pipeline route – Alternative 6 *(cont'd)*

NORTH PIPELINE OPTION					
Grazing Allotment	**Private (acres)**	**NFS (acres) / AUMs**	**ASLD (acres) / AUMs**	**BLM (acres) / AUMs**	**Total Grazing Reduction (acres)**
Superior	24	884 / 83	0	0	**908**
Victory Cross	833	0	1,607 / 376	0	**2,440**
Total					**15,209**

Constructed stock watering and/or wildlife water facilities in the tailings pipeline corridor options could be present yet are not listed in table 3.16.4-8. It is expected that the water sources would be avoided during micro-siting or would be replaced in accordance with water resources mitigation. Impacts associated with water sources in the tailings pipeline corridor options would be associated with construction and therefore short term and temporary.

3.16.4.8 Cumulative Effects

The Tonto National Forest identified the following list of reasonably foreseeable future actions as likely to occur in conjunction with development of the Resolution Copper Mine, and as having potential to contribute to incremental changes in regional livestock and grazing conditions near the Resolution Copper Mine. As noted in section 3.1, past and present actions are assessed as part of the affected environment; this section analyzes the effects of any RFFAs, to be considered cumulatively along with the affected environment and Resolution Copper Project effects.

- **Ripsey Wash Tailings Project.** ASARCO mining company is planning to construct a new tailings storage facility to support its Ray Mine operations. The tailings storage facility is to be situated in the Ripsey Wash watershed just south of the Gila River approximately 5 miles west-northwest of Kearny, Arizona. The new tailings storage facility would be designed to replace the existing Elder Gulch tailings storage facility and would be operated with the current on-site workforce. There would be relatively minor change to existing grazing allotments, with the A-Diamond Allotment losing 2,426 acres or about 11.5 percent of area; and the Rafter Six Allotment being reduced by 149 acres, or about 0.06 percent of its area. These impacts would primarily be cumulative with Alternative 5 – Peg Leg, as the tailings storage facility would also impact another 2,564 to

Table 3.16.4-8. Water sources impacted under Alternative 6

Name	Type	Nearest Project Area	Grazing Allotment
NORTH PIPELINE OPTION			
Name	**Type**	**Nearest Project Area**	**Grazing Allotment**
Weeping Spring	Spring	Access road	Government Spring
Big Spring 3	Spring	Fence line	Victory Cross
Looney Spring 2	Spring	Fence line	Slash S
Walnut Spring 4	Spring	Fence line	Slash S
Dry Spring	Spring	Tailings facility	Slash S
Haley Spring	Spring	Tailings facility	Slash S
No Name	Stock tank	Access road	Devil's Canyon
SOUTH PIPELINE OPTION			
Name	**Type**	**Nearest Project Area**	**Grazing Allotment**
Weeping Spring	Spring	Access road	Government Spring
Big Spring 3	Spring	Fence line	Victory Cross
Looney Spring 2	Spring	Fence line	Slash S
Walnut Spring 4	Spring	Fence line	Slash S
Dry Spring	Spring	Tailings facility	Slash S
Haley Spring	Spring	Tailings facility	Slash S
No Name	Stock tank	Access road	Devil's Canyon

Sources: WestLand Resources Inc. and Montgomery and Associates Inc. (2018); WestLand Resources Inc. (2018d)

2,772 acres of the A-Diamond Allotment, depending on pipeline route.

- **Ray Land Exchange and Proposed Plan Amendment.** ASARCO is also seeking to complete a land exchange with the BLM by which the mining company would gain title to approximately 10,976 acres of public lands and federally owned mineral estate located near ASARCO's Ray Mine in exchange for transferring to the BLM approximately 7,304 acres of private lands, primarily in northwestern Arizona. It is known that at some point ASARCO wishes to develop a copper mining operation in the "Copper Butte" area west of the Ray Mine; however, no specific details are currently available as to potential environmental effects resulting from this future mining operation. Under the proposed action, livestock grazing would cease on the selected lands, resulting in a reduction of 1,151 AUMs; however, the offered lands could become available for grazing under Federal jurisdiction.
- **Grazing allotments.** There are various portions of 17 discrete grazing allotments that partially overlap the proposed Resolution Copper Mine. The grazing allotments generally allow for cattle and other livestock grazing, as well as minor range improvements such as fence repair, stock watering improvements, cattle guards, etc. Approximately 40,000 acres of land authorized for livestock grazing would be affected in varying degrees by proposed project activities and its alternatives. The degree of impacts would be dependent upon the activity, e.g., proposed pipeline and transmission line corridors would not notably affect livestock access and forage would return in time, while tailings facilities and other materials processing areas would likely be lost in perpetuity.
- **APS Herbicide Use within Authorized Power Line Rights-of-Way on NFS lands**. APS has proposed to include Forest Service–approved herbicides as a method of vegetation management, in addition to existing vegetation treatment methods, on existing APS transmission rights-of-way within the Tonto National Forest. An EA with a FONSI was published in December 2018. The EA determined that environmental resource impacts would be minimal, and the use of herbicides would be useful in preventing and/or reducing fuel buildup that would otherwise result from rapid, dense regrowth and sprouting of undesired vegetation. While some vegetation would be unavailable for grazing, the cumulative effect overall would be negligible.
- **LEN Range Improvements.** This range allotment is located near Ray Mine. Under the proposed action, upland perennial sources of water would be provided to supplement the existing upland water infrastructure on the allotment. The supplemental water sources would provide adequate water facilities for existing authorized grazing management activities. While beneficial, these water sources are located in a different geographic area than the GDEs potentially impacted by the Resolution Copper Project.
- **Millsite Range Improvements.** This range allotment is located 20 miles east of Apache Junction, on the southern end of the Mesa Ranger District. The Mesa Ranger District is proposing to add three new 10,000-gallon storage tanks and two 600-gallon toughs to improve range condition through better livestock distribution and to provide additional wildlife waters in three pastures on the allotment. Water developments are proposed within the Cottonwood, Bear Tanks, and Hewitt pastures of the Millsite grazing allotment. These improvements would be beneficial for providing water on the landscape, and are within the same geographic area where some waters sources could be lost (Alternatives 2 and 3); they may offset some loss of water that would result because of the Resolution Copper Project tailings storage facility construction.

Other future projects not yet planned, such as large-scale mining, pipeline projects, power transmission line projects, and future grazing permits, are expected to occur in this area of south-central Arizona during the foreseeable future life of the Resolution Copper Mine (50–55

years). These types of unplanned projects, as well as the specific RFFAs listed here, would contribute to changes in lands available for livestock grazing use, and would affect the vegetation available as livestock forage.

3.16.4.9 Mitigation Effectiveness

The Forest Service is in the process of developing a robust mitigation plan to avoid, minimize, rectify, reduce, or compensate for resource impacts that have been identified during the process of preparing this EIS. Appendix J contains descriptions of mitigation concepts being considered and known to be effective, as of publication of the EIS. Appendix J also contains descriptions of monitoring that would be needed to identify potential impacts and mitigation effectiveness. As noted in chapter 2 (section 2.3), the full suite of mitigation would be contained in the FEIS, required by the ROD, and ultimately included in the final GPO approved by the Forest Service. Public comment on the DEIS, and in particular appendix J, will inform the final suite of mitigations.

At this time, no mitigation measures have been identified that would be pertinent to livestock grazing. Applicant-committed environmental protection measures for other resources that would also benefit livestock grazing have already been detailed elsewhere in this EIS, will be a requirement for the project, and have already been incorporated into the analysis of impacts.

Unavoidable Adverse Effects

Grazing would be impacted by a reduction in the area available for grazing (a permanent reduction for the area of the subsidence crater and tailings storage facility; a temporary reduction for the area within the perimeter fence until reclamation returns the area to a condition that is compatible with livestock grazing), and by impacts on seeps, springs, and stock tanks that are used by livestock. Water source enhancement conservation measures may offset some of the impacts on seeps, springs, and stock tanks used by livestock on current grazing allotments. These impacts cannot be avoided or fully mitigated.

3.16.4.10 Other Required Disclosures

Short-Term Uses and Long-Term Productivity

Livestock grazing and long-term productivity would be permanently impacted within the tailings storage facility and subsidence area. Although reclamation would eventually return some level of vegetation to the tailings storage facility, productivity would be unlikely to recover to current conditions. Existing grazing around the MARRCO corridor and other linear corridors would be short-term losses, ending with reclamation at the end of mine life, with no impact on long-term productivity.

Irreversible and Irretrievable Commitment of Resources

Vegetation on the site would be continually changing as reclamation procedures are implemented. Eventually, reclamation is expected to return the site to conditions potentially suitable for post-closure land uses such as grazing. Irretrievable commitment of grazing resources would occur until reclamation has returned the site to conditions suitable for grazing. However, the subsidence area and tailings storage facility likely represent an irreversible loss of grazing land.

3.17 Required Disclosures

This section addresses additional disclosures that are required by CEQ regulations and/or NEPA.

3.17.1 Short-Term Uses and Long-Term Productivity

NEPA requires consideration of "the relationship between short-term uses of man's environment and the maintenance and enhancement of long-term productivity" (40 CFR 1502.16). As declared by Congress, this includes using all practicable means and measures, including financial and technical assistance, in a manner calculated to foster and promote the general welfare, create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations of Americans (NEPA Section 101).

This portion of NEPA regulations recognizes that short-term uses and long-term productivity of the environment are linked and that opportunities that are acted upon have corollary opportunity costs in terms of forgone options and productivity that could have continuing effects well into the future. The following discussion examines short-term uses and long-term productivity together, according to resource categories. Specific impacts of the proposed project on resources are described in the various resource sections throughout chapter 3. "Short term" is taken to mean the full life of the project (construction, operation, and post-closure phases).

The relationships between short-term uses and long-term productivity would not be appreciably different from one action alternative to another but instead would come largely from whether the project is constructed. Resource areas not listed are not expected to have adverse environmental impacts for which maintenance of long-term productivity is a concern.

3.17.1.1 Geology, Minerals, and Subsidence

Construction of the project would convert some undeveloped lands into an industrial mining operation, and construction of mine facilities would alter the area's topography. Impacts related to subsidence and the tailings storage facilities would permanently impact long-term productivity.

3.17.1.2 Soils and Vegetation

Productivity loss for soils would be limited to the disturbed areas affected by land clearing, grading, and construction; subsidence; and areas permanently occupied by tailings. It is not expected that the tailings would ever be removed, or that the subsidence crater would be filled. Effects on soils and some land uses would be permanent.

Reclamation efforts are anticipated to reestablish vegetation in all areas other than the subsidence crater.

Test plots at the West Plant Site have demonstrated that it is possible to successfully revegetate under certain conditions and research has demonstrated successful revegetation on Gila Conglomerate in the same geographic area; however, it is not known whether the areas would return to current conditions or the length of time that would be needed to successfully reclaim the site. However, the goal of reclamation is to create a self-sustainable ecosystem that would promote site stability and repair hydrologic function, and while pre-project habitat conditions are not likely to be achieved, it is likely that some level of wildlife habitat would eventually be reestablished in most areas, reestablishing some level of long-term productivity.

3.17.1.3 Noise and Vibration

Modeled noise and vibration levels did not rise beyond threshold of concern under most conditions, but the noise and vibration associated with the surrounding environment from mining and associated activities would be short term (during the estimated 46- to 51-year life of the mine between construction and reclamation) and are expected to end with mine reclamation.

3.17.1.4 Transportation and Access

Impacts from increased mine-related traffic would be short-term impacts that would cease when the mine is closed.

3.17.1.5 Air Quality

Impacts on air quality (increased air pollutant concentrations but below applicable air quality standards) from mining and associated activities would be short term (during the estimated 41- to 51-year life of the mine between construction and reclamation) and are expected to end with mine reclamation and return to pre-mining levels, assuming adequate revegetation success to stabilize dust emissions from disturbed areas.

3.17.1.6 Groundwater Quantity and Groundwater-Dependent Ecosystems

Groundwater pumping would last the duration of the mine life. At the mine itself, groundwater levels would slowly equilibrate over a long period (centuries). Groundwater drawdown from dewatering of the underground mine workings would constitute a permanent reduction in the productivity of groundwater resources within the long time frame expected for equilibrium. Groundwater in the vicinity of the Desert Wellfield would equilibrate more quickly, but there would still be an irrecoverable amount of drawdown and a permanent loss of productivity of groundwater resources in the area.

Seeps and springs could be permanently impacted by drawdown in groundwater levels, as could the riparian areas associated with springs, but these impacts would be mitigated. GDEs or riparian areas directly lost to surface disturbance would be a permanent impact.

3.17.1.7 Groundwater and Surface Water Quality

The use of the alternative sites for tailings storage represents a short-term use, with disposal happening over the operational life of the mine. However, the seepage from the tailings facilities would continue for much longer, with potential management anticipated being required over 100 years in some cases. While seepage persists, the long-term productivity of the downstream aquifers and surface waters could be impaired for some alternatives.

3.17.1.8 Surface Water Quantity

Desert washes, stock tanks, and wetland areas in the footprint of the subsidence area and tailings storage facility would be permanently impacted. In the short term, over the operational life of the mine, precipitation would be lost to the watershed. In the long term, most precipitation falling at the tailings facility would return to the watershed after closure and successful reclamation. There would be a permanent reduction in the quantity of surface water entering drainages as a result of capture of runoff by the subsidence area.

3.17.1.9 Wildlife and Special Status Wildlife Species

Impacts on wildlife and wildlife habitat would primarily be short term and would include destruction of habitat for mine construction, disturbance from mining and associated activities, and direct mortality from increased mine-related vehicle traffic. Disturbance and direct mortality would cease at mine closure, and reclamation would eventually allow wildlife habitat to reestablish itself. However, this could take many decades or longer. Portions of the tailings storage facility landform may never return to pre-mining conditions, and the effects of reduced quality of habitat would be long term or permanent. Impacts on wildlife and aquatic habitat due to drawdown that affects streams and springs would represent a permanent loss in productivity.

3.17.1.10 Recreation

Recreation would be impacted in both the short and long term. Public access would be restricted within the perimeter fence until mine closure, which is considered to be a short-term impact. However, much or all

of the tailings and subsidence area may not be available for uses such as OHV or other recreational use in the future, depending on the final stability and revegetation of these areas.

3.17.1.11 Public Health and Safety

Impacts from risk associated with tailings embankment safety would exist for a long time on the landscape and may result in some land uses downstream of the facility being curtailed. Over time, the reduction of risk would diminish, and productivity of downstream areas would recover.

Impacts from increased mine-related traffic, increased fire hazard, and hazardous materials use in mine operations would be short-term impacts that would end with mine reclamation.

3.17.1.12 Scenic Resources

Impacts on visual resources would be both short and long term. While impacts associated with processing plant buildings and structures such as utility lines and fences would cease when they are removed at closure, the subsidence area and tailings storage facility would permanently alter the scenic landscape and affect the scenic quality of the area in perpetuity. Impacts on dark skies from night lighting would cease after mine closure and reclamation.

3.17.1.13 Cultural Resources

Physical and visual impacts on archaeological sites, tribal sacred sites, cultural landscapes, and plant and mineral resources caused by construction of the mine would be immediate, permanent, and large in scale. Mitigation measures cannot replace or replicate the historic properties that would be destroyed by project construction. The landscape, which is imbued with specific cultural attributions by each of the consulted tribes, would also be permanently affected.

3.17.1.14 Socioeconomics

Socioeconomic impacts are both positive and negative and are primarily short term. The project would provide increased jobs and tax revenue from construction through final reclamation and closure. However, this would be offset by potential impacts on local tourism and outdoor recreation economies, and a decrease in nearby property values; as these effects are largely the result of the tailings storage facility, which is a permanent addition to the landscape, they could persist over the long term.

The long-term continued population and economic growth in areas of the Copper Triangle with existing copper mines indicates that these impacts are in the magnitude of being decades long and would not be permanent.

3.17.1.15 Tribal Values and Concerns

Physical and visual impacts on TCPs, TEKPs, and plant and mineral resources caused by construction of the mine would be immediate, permanent, and large in scale. Mitigation measures cannot replace or replicate the tribal resources and traditional cultural properties that would be destroyed by project construction. The landscape, which is imbued with specific cultural attributions by each of the consulted tribes, would also be permanently affected.

3.17.1.16 Environmental Justice

Environmental justice impacts are expected only for the town of Superior and tribes with cultural, social, or religious ties to the project area. These populations would be affected permanently from direct, permanent impacts on these sites and values. The loss of these values would be long term.

3.17.1.17 Livestock and Grazing

Livestock grazing and long-term productivity would be permanently impacted within the tailings storage facility and subsidence area.

Although reclamation would eventually return some level of vegetation to the tailings storage facility, productivity would be unlikely to recover to current conditions. Existing grazing around the MARRCO corridor and other linear corridors would be short-term uses, ending with reclamation at the end of mine life, with no impact on long-term productivity.

3.17.2 Unavoidable Adverse Effects

As required by CEQ regulations implementing NEPA (40 CFR 1502.16), this EIS describes the adverse or significant environmental effects that cannot be avoided from implementation of the proposed project or alternatives. In the resource sections of this chapter, the direct, indirect, and cumulative environmental effects of the project are discussed in detail. Impacts that are significant and cannot be avoided are summarized in the following text. Refer to the referenced resource section in this chapter for a complete description of these impacts. Resource areas that are not listed are not expected to experience unavoidable adverse effects.

3.17.2.1 Geology, Minerals, and Subsidence

Unavoidable adverse impacts would occur through disturbance caused by the subsidence, to a small area of Martin limestone with potential paleontological resources (Alternatives 2 and 3), and to unpatented mining claims not associated with the Resolution Copper Project (all tailings facilities and/or pipeline corridors). Impacts on cave/karst resources and to the public from geological hazards from access to the subsidence area, induced seismicity, or damage to Apache Leap are not considered likely to occur.

3.17.2.2 Soils and Vegetation

The mitigation described would only minimally offset project impacts. The unavoidable adverse effects remain as described, including the complete loss during operations of soil productivity, vegetation, and functioning ecosystems within the area of disturbance, and eventual recovery after reclamation (though not likely to the level of desired conditions, and potentially over extremely long time frames). Impacts on special status plant species, where they occur, and the spread of noxious and invasive weeds (though reduced by applicant-committed environmental protection measures) would also be unavoidable adverse effects.

3.17.2.3 Noise and Vibration

No impacts above selected thresholds were identified from construction blasting noise and vibration (provided explosive loading is appropriately limited), from construction non-blasting noise (beyond 1,000 feet from active equipment), or from operational vibrations (beyond 50 feet from active equipment).

For operational noise, with the exception of Dripping Springs Road, the only impacts identified above selected thresholds were associated with the maximum range of impacts, which is an infrequent and unlikely scenario that suggests that all equipment is running simultaneously and during the quietest period (i.e., lowest background levels observed). Under most conditions, the analysis indicates that no impacts would be expected from project noise.

Application of the mitigation of rerouting traffic from Dripping Springs Road would eliminate those operational noise impacts as well.

After mitigation, no unavoidable adverse impacts are anticipated from noise or vibration.

3.17.2.4 Transportation and Access

Increased traffic associated with mine worker commuting and truck traffic to and from the mine are expected to result in impacts that cannot be avoided or fully mitigated, including increased traffic congestion and increased risk of traffic accidents. Decreases in LOS to subpar levels (LOS E or F) would occur at several intersections due to mine traffic, unless traffic changes were made to accommodate the increased traffic. The only applicant-committed environmental protection measure that

would alleviate impacts on level of service would be the addition of turn lanes at the SR 177/U.S. 60 intersection.

Access to the Oak Flat area, including Devil's Canyon and Apache Leap, would be maintained to an extent, but using less-direct routes than NFS Road 315 that currently provides the primary access. Loss of access to these areas would be mitigated, but not fully.

Loss of access to the highlands north of the West Plant Site would be fully offset for Alternatives 2, 3, 5, and 6 by rerouting the road. Loss of access to the general public under Alternative 4 would not be mitigated by this measure, as only administrative access would be maintained.

All alternatives, including Alternative 6, could result in some loss of access to mining activities and grazing facilities in the area around the tailings storage facilities.

3.17.2.5 Air Quality

For the proposed action and all alternatives, emissions from mine-related activities would meet applicable Federal and State standards for air quality but the increase in air pollutant concentrations would constitute impacts that cannot be avoided.

3.17.2.6 Groundwater Quantity and Groundwater-Dependent Ecosystems

Given the effectiveness of mitigation, there would be no residual impacts on public water supplies near the mine site. All lost water supplies would be replaced.

For GDEs expected to be impacted by groundwater drawdown, the mitigation measures described would be effective enough that there would be no net loss of riparian ecosystems or aquatic habitat on the landscape, although the exact nature and type of ecosystems would change to adapt to new water sources. However, impacts on the sense of place and nature experienced at these perennial streams and springs, rare in a desert environment, would not be mitigated by these actions.

The mitigation plan would not mitigate any GDEs lost directly to surface disturbance, ranging from two to five, depending on tailings alternative.

Impacts on water supplies in the East Salt River valley in the form of groundwater drawdown and reduction of regional groundwater supply would not be fully mitigated.

3.17.2.7 Groundwater and Surface Water Quality

The applicant-committed environmental protection measures for stormwater control would effectively eliminate any runoff in contact with ore or tailings. There are no anticipated unavoidable adverse effects associated with the quality of stormwater runoff.

Seepage from the tailings storage facilities has a number of unavoidable adverse effects. In all cases, the tailings seepage adds a pollutant load to the downstream environment, including downstream aquifers and downstream surface waters where groundwater eventually daylights. The overall impact of this seepage varies by alternative. Alternatives 2, 3, and 4 all either have anticipated impacts on water quality or have a high risk to water quality because of the extreme seepage control measures that must be implemented, and the relative inflexibility of adding more measures as needed, given the proximity to Queen Creek.

Alternatives 5 and 6 are located at the head of larger alluvial aquifers with some distance downstream before the first perennial water (the Gila River). Adverse effects are not anticipated from these alternatives, and in addition these locations offer more flexibility in responding to potential problems with additional seepage controls.

3.17.2.8 Surface Water Quantity

The primary impact described in the analysis (in this section, as well as section 3.7.1) is the loss of surface water flow to riparian areas (including xeroriparian vegetation along ephemeral washes) and loss of surface flow to any GDEs that are associated with these drainages. With the possible exception of the Queen Creek project, the conceptual mitigation proposed under the Clean Water Act would not be effective at

avoiding, minimizing, rectifying, or reducing these impacts. Rather, the proposed conceptual mitigation would be mostly effective at offsetting impacts caused by reduced surface water flows by replacing riparian function far upstream or downstream of project impacts.

As the subsidence area is unavoidable, the loss of runoff to the watershed due to the subsidence area is also unavoidable, as are any effects on GDEs from reduced annual flows. The loss of water to the watershed due to the tailings facility (during operations, prior to successful reclamation) is unavoidable as well, due to water management and water quality requirements. Direct impacts on wetlands, stock tanks, and ephemeral drainages from surface disturbance are also unavoidable.

3.17.2.9 Wildlife and Special Status Wildlife Species

Biological resources would be impacted by direct surface disturbance, noise, vibration, light, dust, air pollutants, and traffic. Adverse impacts that cannot be avoided or completely mitigated include changes in cover, changes in foraging efficiency and success, changes in reproductive success, changes in growth rates of young, changes in predator–prey relationships, increased movement, habitat fragmentation and disruption of dispersal and migration patterns through animal movement corridors, and increased roadkill.

3.17.2.10 Recreation

Recreational use of the area would be permanently adversely impacted. Unavoidable adverse impacts on recreation include long-term displacement from the project area, and the loss of public access roads throughout the project area. These impacts cannot be avoided or fully mitigated.

3.17.2.11 Public Health and Safety

The mine and associated activities are expected to increase risks to public health and safety from the presence of a large tailings storage facility on the landscape, and the transport of concentrate and tailings by pipeline. These risks are unavoidable. However, risk of failure is minimized by required adherence to National Dam Safety Program and Aquifer Protection Permit program standards and by applicant-committed environmental protection measures.

While increased risk of fire ignition from mine activities cannot be entirely prevented, risks are expected to be substantially mitigated through adherence to a fire plan that requires mine employees to be trained for initial fire suppression and to have fire tools and water readily available.

While the risk of hazardous materials spills would increase during construction and active mining phases, following applicable Federal and State laws and regulations for storage, transport, and handling of such materials is expected to mitigate for this risk. Resolution Copper has prepared a wide variety of emergency response and material handling plans; implementation of these plans minimizes the risk for unexpected releases of hazardous materials and provides for rapid emergency cleanup.

3.17.2.12 Scenic Resources

The subsidence area and residual tailings storage facility would constitute a permanent adverse impact that cannot be avoided or completely mitigated. While night brightness from mine facility lighting would be mitigated to a large degree, residual impacts would remain that are not avoidable and cannot be completely mitigated.

3.17.2.13 Cultural Resources

Cultural resources and historic properties and uses would be directly and permanently impacted. These impacts cannot be avoided within the areas of surface disturbance, nor can they be fully mitigated. The land exchange is also considered an unavoidable adverse effect on cultural resources.

3.17.2.14 Socioeconomics

Loss of jobs in the local tourism and outdoor recreation industries cannot be avoided or fully mitigated. Likewise, loss in property values for property close to the mine would constitute an impact that cannot be avoided or fully mitigated. The applicant-committed environmental protection measures would be effective at expanding the economic base of the community and improving resident quality of life, and could partially offset the expected impacts, although many of the current agreements would expire prior to full construction of the mine.

3.17.2.15 Tribal Values and Concerns

Significant tribal properties and uses would be directly and permanently impacted. These impacts cannot be avoided within the areas of direct impact, nor can they be fully mitigated.

3.17.2.16 Environmental Justice

The change in scenery and dark skies for the town of Superior cannot be avoided or fully mitigated. Similarly, the disproportionately high and adverse impacts on cultural resources and tribal values and concerns cannot be avoided or fully mitigated.

3.17.2.17 Livestock and Grazing

Grazing would be impacted by a reduction in the area available for grazing (a permanent reduction for the area of the subsidence crater and tailings storage facility; a temporary reduction for the area within the perimeter fence until reclamation returns the area to a condition that is compatible with livestock grazing), and by impacts on seeps, springs, and stock tanks that are used by livestock. Water source enhancement conservation measures may offset some of the impacts on seeps, springs, and stock tanks used by livestock on current grazing allotments. These impacts cannot be avoided or fully mitigated.

3.17.2.18 Irreversible and Irretrievable Commitments of Resources

As required by NEPA, this section also includes a discussion by resource of any irreversible or irretrievable commitment of resources that would result from implementing any of the action alternatives. Irreversible and irretrievable commitment of resources is defined as follows in FSH 1909.15 (U.S. Forest Service 2012a):

> Irretrievable. A term that applies to the loss of production, harvest, or use of natural resources. For example, some or all of the timber production from an area is lost irretrievably while an area is serving as a winter sports site. The production lost is irretrievable, but the action is not irreversible. If the use changes, it is possible to resume timber production.
>
> Irreversible. A term that describes the loss of future options. Applies primarily to the effects of use of nonrenewable resources, such as minerals or cultural resources, or to those factors, such as soil productivity that are renewable only over long periods of time.

3.17.2.19 Geology, Minerals, and Subsidence

Irreversible commitment of geological and mineral resources would occur with the excavation and relocation of approximately 1.4 billion tons of rock and with the recovery of approximately 40 billion pounds of copper, as well as the burying of any mineral resources below the alternative tailings facilities.

With respect to paleontological and cave/karst resources, a commitment of resources is considered to be irretrievable when project impacts limit the future use or productivity of a nonrenewable resource over a limited amount of time—for example, structures built on top of paleontologically sensitive geological units that might later be removed. A commitment of resources is considered to be irreversible when project

impacts cause a nonrenewable resource to be permanently lost—for example, destruction of significant fossils and loss of associated scientific data.

An irreversible commitment of paleontological resources could occur at the Alternative 2 and 3 tailings storage facility location, where potentially fossil-bearing rocks associated with the Martin limestone could be destroyed in site preparation or buried permanently.

3.17.2.20 Soils and Vegetation

Soils are a finite resource, and any loss of soils resulting from their removal for tailings storage and from erosion and delivery to downstream channels is irreversible. The loss of soil productivity is effectively irreversible because a stable new plant community would take an extremely long time to redevelop on the surface of the tailings and waste-rock facilities (decades or centuries). The area of the subsidence crater and tailings storage facility would constitute an irreversible loss of soil that would be lost in perpetuity.

Irretrievable effects on soils and vegetation would take place at disturbed areas where reclamation is successfully accomplished or only temporary in nature, particularly along rights-of-way. Soils and vegetation in these areas would eventually return to full functionality, possibly within years or decades.

3.17.2.21 Noise and Vibration

Irretrievable commitment of resources would consist of mine-related noise during the construction, mining, closure, and reclamation phases of the mine. Because the mine-related noise would cease after closure of the mine, noise impacts would not be considered an irreversible commitment of resources.

3.17.2.22 Transportation and Access

Irretrievable impacts on transportation and access would occur as a result of an increase of traffic on State, County, and public NFS roads from mining and related activities within the analysis area and from the reduction of public access to roads within the perimeter fence. Because mine-related traffic would cease after mine closure, traffic impacts would not be considered an irreversible commitment of resources. Existing roads that would be decommissioned within the perimeter fence of the mine would constitute both an irreversible and irretrievable commitment of resources. Roads that are permanently covered with tailings or within the subsidence crater would be an irreversible commitment, while those that are cut off to public access by the perimeter fence could potentially be restored or rerouted following mine closure, and therefore are considered to be an irretrievable commitment of resources.

3.17.2.23 Air Quality

During the construction and mining phases of the project, air pollutant concentrations would be higher throughout the analysis area than current levels but within applicable air quality standards; thus, air quality is not impacted for other uses in the airshed and these effects would not be considered irretrievable. Following mine closure and successful reclamation, pollutant concentrations would return to pre-mining levels, and there would be no long-term irreversible commitment of resources.

3.17.2.24 Groundwater Quantity and Groundwater-Dependent Ecosystems

Mine dewatering at the East Plant Site under all action alternatives would result in the same irretrievable commitment of 160,000 acre-feet of water from the combined deep groundwater system and Apache Leap Tuff aquifer over the life of the mine.

Changes in total groundwater commitments at the Desert Wellfield vary by alternative for tailings locations and tailings type. Alternative 4 would require substantially less water overall than the other alternatives (176,000 acre-feet, vs. 586,000 acre-feet for Alternative 2). Loss of this water from the East Salt River valley aquifer is an irretrievable impact; the use of this water would be lost during the life of the mine.

While a number of GDEs and riparian areas could be impacted by groundwater drawdown, these changes are neither irreversible nor irretrievable, as mitigation would replace water sources as monitoring identifies problems. However, even if the water sources are replaced, the impact on the sense of nature and place for these natural riparian systems would be irreversible. In addition, the GDEs directly disturbed by the subsidence area or tailings alternatives represent irreversible impacts.

3.17.2.25 Groundwater and Surface Water Quality

The potential impacts on water quality from tailings seepage would cause an irretrievable commitment of water resources downstream of the tailings storage facility, lasting as long as seepage continued. Eventually, the seepage amount and pollutant load would decline, and water quality conditions would return to a natural state. This may take over 100 years to achieve in some instances.

While long lived, the impacts on water quality would not be irreversible, and would eventually end as the seepage and pollutant load declined.

3.17.2.26 Surface Water Quantity

With respect to surface water flows from the project area, all action alternatives would result in both irreversible and irretrievable commitment of surface water resources. Irreversible commitment of surface water flows would result from the permanent reduction in stormwater flows into downstream drainages from the subsidence area. Changes to wetlands, stock tanks, and ephemeral drainages caused by surface disturbance would also be irreversible. Irretrievable commitment of surface water resources would be associated with additional temporary diversion, storage, and use of stormwater during active mining, but that would be restored to the watershed after closure and reclamation.

3.17.2.27 Wildlife and Special Status Wildlife Species

The direct loss of productivity of thousands of acres of various habitat from the project components would result in both irreversible and irretrievable commitment of the resources that these areas provide for wildlife (i.e., wildlife breeding, foraging, wintering, and roosting habitat; animal movement corridors, etc.). Some habitat could reestablish after closure, which would represent an irretrievable commitment of resources. However, portions of the tailings storage facility landform may never return to pre-mining conditions, and the effects of reduced quality of habitat would likely be irreversible.

3.17.2.28 Recreation

In general, there would be irretrievable and irreversible impacts as a result of displaced recreation users and adverse effects on recreation experiences and activities. There would be irretrievable impacts on recreation with all action alternatives. Alternatives 2, 3, and 5 with the west corridor would cross the Arizona National Scenic Trail. Alternative 4 would require rerouting of the trail.

Each action alternative would result in the permanent removal of off-highway routes, resulting in a permanent loss of recreation opportunities and activities. Public access would only be permitted outside the mine perimeter fence. Although routes through the project area might be reestablished after closure of the East Plant Site, West Plant Site, filter plant and loadout facility, and the MARRCO corridor, routes through the subsidence crater and tailings storage facility likely would not be reestablished. Therefore, impacts on OHV routes are considered irretrievable for those that would be reestablished following mine closure, and irreversible for those that would be permanently affected.

Even after full reclamation is complete, the post-mine topography of the project area may limit the recreation value and potential for future recreation opportunities.

3.17.2.29 Public Health and Safety

Irreversible changes with respect to tailings safety are not expected. The risk from pipeline failures ends upon closure of the mine. The risk from a tailings storage facility would persist for decades but would diminish as the structure drains. Impacts on public safety from tailings or tailings and concentrate pipelines would constitute an irretrievable commitment of resources.

With respect to fuels and fire management, there are not expected to be any irretrievable or irreversible changes to resources. Vegetation and fuels in the project area would be constantly changing as reclamation procedures are implemented. Eventually, reclamation is expected to return site vegetation to a state that is reminiscent of existing vegetation communities in the area.

Irreversible changes with respect to public health and safety are not expected. All potential hazards discussed are limited solely to the construction and operation phases and are not expected to remain after closure of the mine. Therefore, they would constitute an irretrievable commitment of resources.

With respect to hazardous materials, there are not expected to be any irretrievable or irreversible changes to resources. Although there is the potential for contamination of surface water, groundwater, or soils in the event of a spill or accidental release, such an occurrence is not expected to occur, and environmental remediation is possible (and required by law) if it does occur.

3.17.2.30 Scenic Resources

For all action alternatives, there would be an irretrievable loss of scenic quality from increased activity and traffic during the construction and operation phases of the mine. The size and extent of the tailings facilities would create losses of scenic quality until rock weathering and slope revegetation have reduced color, form, line, and texture contrasts to a degree that they blend in with the surrounding landscape; revegetation would occur relatively soon after closure, but weathering would take such a long time scale as to be considered permanent. Due to the geological time frame necessary for these processes to occur, the loss of scenic quality associated with the tailings facilities would effectively be irreversible.

For each action alternative, the visual contrasts that would result from the introduction of facilities associated with the project would be an irretrievable loss of the undeveloped, semiprimitive setting until the project is closed and full reclamation is complete. Under all of the action alternatives, existing views would be irreversibly lost behind the tailings storage facility because of the height and extent of the piles.

There would be an irretrievable, regional, long-term loss of night-sky viewing during project construction and operations because night-sky brightening, light pollution, and sky glow caused by mine lighting would diminish nighttime viewing conditions in the direction of the mine. Impacts on dark skies due to night lighting would cease after mine closure and reclamation. Regional dark skies would continue to brighten due to other development factors in the region throughout the mine life. Therefore, it is unlikely that a return to current dark sky conditions would occur after mine closure.

3.17.2.31 Cultural Resources

The direct impacts on cultural resources and historic properties from construction of the mine and associated facilities constitute an irreversible commitment of resources. Archaeological sites cannot be reconstructed once disturbed, nor can they be fully mitigated. Sacred springs would be eradicated by subsidence or tailings storage construction and affected by groundwater water drawdown. Changes that permanently affect the ability of tribal members to use known TCPs for cultural and religious purposes are also an irreversible commitment of resources.

3.17.2.32 Socioeconomics

Some changes in the nature of the surrounding natural setting and landscape would be permanent, including the tailings storage facility and the subsidence area. The action alternatives would therefore potentially

cause irreversible impacts on the affected area with regard to changes in the local landscape, community values, and quality of life.

3.17.2.33 Tribal Values and Concerns

The direct impacts on TCPs and TEKPs from construction of the mine and associated facilities constitute an irreversible commitment of resources. Traditional cultural properties cannot be reconstructed once disturbed, nor can they be fully mitigated. Sacred springs would be eradicated by subsidence or tailings storage construction and affected by groundwater water drawdown. Changes that permanently affect the ability of tribal members to use known TCPs and TEKPs for cultural and religious purposes are also an irreversible commitment of resources. For uses such as gathering of traditional materials from areas that would be within the subsidence area or the tailings storage facility, the project would constitute an irreversible commitment of resources.

3.17.2.34 Environmental Justice

There would be irretrievable socioeconomic impacts under all action alternatives because existing land uses, including recreation opportunities, would be precluded within the project area during the life of the project. All action alternatives would potentially cause irreversible impacts on the affected area with regard to changes in the local landscape, infrastructure and tax base funding, community values, and quality of life for residents of the town of Superior.

3.17.2.35 Livestock and Grazing

Vegetation on the site would be continually changing as reclamation procedures are implemented. Eventually, reclamation is expected to return the site to conditions potentially suitable for post-closure land uses such as grazing. Irretrievable commitment of grazing resources would occur until reclamation has returned the site to conditions suitable for grazing. However, the subsidence area and tailings storage facility likely represent an irreversible loss of grazing land.

3.17.2.36 Cumulative Effects

Cumulative effects analysis has been conducted, and the results are addressed by each individual resource in chapter 3.

3.17.2.37 Other Required Disclosures

The Tonto National Forest will consult with the following agencies, as required by pertinent law and regulation.

3.17.2.38 Consultation under the Endangered Species Act

The Tonto National Forest will begin consultation with the FWS regarding species protected under Section 7 of the ESA once a preferred alternative is identified. All reasonable and prudent measures and terms and conditions specified in the biological opinion are nondiscretionary and would be included as components of the decision in the ROD and final mining plan of operations.

3.17.2.39 Consultation under the National Historic Preservation Act

The Tonto National Forest continues to consult with the Advisory Council on Historic Preservation, BLM, Arizona SHPO, ASLD, and 15 Indian Tribes regarding cultural resources protected under Section 106 of the National Historic Preservation Act. A Programmatic Agreement is being drafted at this time with all parties involved (see appendix O of this EIS). All agreements and mitigation measures specified in the PA and the historic properties treatment plan are nondiscretionary and would be included as components of the decision in the ROD.

3.17.2.40 Conflicts with Regional, State, and Local Plans, Policies, and Controls

NEPA at 40 CFR 1502.16 directs, "Statements shall discuss (c) Possible conflicts between the proposed action and the objectives of Federal, regional, State, and local (and in the case of a reservation, Indian Tribe) land use plans, policies and controls for the area concerned. (See 1506.2(d).)."

Title 40 CFR 1506.2(d) states, "To better integrate environmental impact statements into State or local planning processes, statements shall discuss any inconsistency of a proposed action with any approved State or local plan and laws (whether or not federally sanctioned). Where an inconsistency exists, the statement should describe the extent to which the agency would reconcile its proposed action with the plan or law."

Plans that are reviewed for compliance include the following.

Federal Agencies

- Tonto National Forest Land and Resource Management Plan (1985, amended through 2017)
- Tonto National Forest Travel Management Plan
- BLM Safford District Resource Management Plan (1992, 1994)
- BLM Lower Sonoran and Sonoran Desert National Monument Resource Management Plan (2012)
- BLM Middle Gila Canyons Travel Management Plan (2010)

State Government

- ADOT Long Range Transportation Plan (2018)
- Arizona State Workforce Development Plan (2016)
- Statewide Comprehensive Outdoor Recreation Plan (2018–2022)
- Arizona State Parks and Trails 5-Year Strategic Plan (2018–2022)
- State Wildlife Action Plan (SWAP) (2012–2022)
- AGFD long-term wildlife and game management plans

Pinal County

- Pinal County Comprehensive Plan 2009 (updated 2015)
- Pinal County Strategic Plan (2017–2020)
- Pinal County Open Space and Trails Master Plan (2007)
- Pinal County State Implementation Plans (SIPs) and applicable Maricopa Association of Governments Regional Air Quality Plans
- Pinal Regional Transportation Plan (2017)
- Pinal County Area Drainage Master Plans
- Central Arizona Council of Governments Regional Transportation Plan (2015)

Gila County

- Gila County Comprehensive Plan (2003, Amended 2018)
- Gila County Land Use and Resource Policy Plan (2010)
- Gila County Small Area Transportation Study (2006)
- Gila County Transportation Study (2014)
- Gila County State Implementation Plan (SIP)

Indian Tribes

- Unknown

CHAPTER 4

Consulted Parties

4.1 Introduction

This chapter provides an overview of the consultation and coordination conducted to date between the Forest Service and Federal, State, and local agencies, tribes, and the public. The FEIS will expand this section to update consultation, agency permitting activities, and additional comments and outreach activities conducted after publication of the DEIS, including cooperating agency review, the EIS public review, and comment analysis and agency response processes.

4.2 Notice of Intent and Scoping

An NOI announcing the intent of the Tonto National Forest to prepare this EIS was published in the Federal Register on March 18, 2016. The notice announced the preparation of this EIS and announced opportunities for public involvement, including scoping meetings. Five public scoping meetings were subsequently held at the locations and on the dates shown in table 1.6.1-1 in chapter 1. The official scoping and public commenting period lasted 120 days, from March 18 to July 18, 2016.

Members of the public were afforded several methods for providing comments during the scoping period. These included multiple comment stations with comment forms or providing oral comments to a court reporter at the scoping meetings, the opportunity to send emails to <comments@resolutionmineeis.us> or to submit letters via U.S. mail to the Tonto National Forest, or to submit written comments in person at the Tonto National Forest Supervisor's Office, 2324 East McDowell Road, Phoenix, AZ 85006, during normal business hours. In total, 133,653 comment submittals were received during the project scoping period.

A comprehensive scoping report summarizing the public meeting and comment process and providing a detailed synopsis of the scoping comments received was released in March 2017. The scoping report (U.S. Forest Service 2017f) is available at the Tonto National Forest Supervisor's Office at the address shown in the previous paragraph.

A website was created to provide access to project schedule, updates, project and alternative information, and baseline data and reports. The website is found at www.ResolutionMineEIS.us and has been active since 2016.

4.3 Project Mailing List

Early in the project NEPA process, an initial mailing list identifying individuals (as points of contact) in organizations, agencies, and interest groups was compiled from Tonto National Forest records of interested parties and from organizations and individuals who submitted comments related to the "Final Environmental Assessment: Resolution Copper Mining Baseline Hydrological and Geotechnical Data Gathering Activities Plan of Operations" (U.S. Forest Service 2016a). Those interested or who had commented on the "Apache Leap Special Management Area Management Plan Environmental Assessment" (U.S. Forest Service 2017a) are also included in this mailing list. After alternatives were developed for detailed analysis, the mailing list was once again updated to include those landowners or stakeholders who would be affected by the alternative tailings locations or associated corridors.

The goal of the mailing list is to enable broad distribution of information to local and regional businesses, organizations, and interested individuals about public meetings, comment period deadlines, and other key project milestones. As of June 2019, the mailing list included approximately 40,000 email and postal service addresses. However, the list has been, and will continue to be, periodically updated and expanded throughout the entire Resolution Copper Project and Land Exchange EIS process.

4.4 Tribal Consultation (Government-to-Government)

Federal agencies are required to consult with American Indian Tribes as part of the Advisory Council on Historic Preservation (ACHP) regulations, Protection of Historic Properties (36 CFR 800), implementing Section 106 of the National Historic Preservation Act (NHPA). Accordingly, the NHPA outlines when Federal agencies must consult with tribes and the issues and other factors this consultation must address. Pursuant to Executive Order 13175, executive departments and agencies are charged with engaging in regular and meaningful consultation and collaboration with tribal officials in the development of Federal policies that have tribal implications and are responsible for strengthening the government-to-government relationship between the United States and Indian Tribes. In addition, the NDAA requires consultation with affected Indian Tribes concerning issues of concern related to the land exchange.

The Tonto National Forest has been conducting tribal consultation related to various Resolution Copper projects, the land exchange, and the Apache Leap SMA environmental assessment. This consultation has included formal and informal meetings, correspondence, sharing information, and documentation of tribal comments and concerns by the Forest Service. The consultation is ongoing and will continue through the end of the project. The following tribes are involved in the consultation process:

- Fort McDowell Yavapai Nation
- Gila River Indian Community
- Hopi Tribe
- Mescalero Apache Tribe
- Pueblo of Zuni
- Salt River Pima-Maricopa Indian Community
- San Carlos Apache Tribe
- Tonto Apache Tribe
- White Mountain Apache Tribe
- Yavapai-Apache Nation
- Yavapai-Prescott Indian Tribe

Additional tribes were included in consultation with the introduction of the Peg Leg alternative location. These tribes, included at the request of the BLM, are as follows:

- Ak-Chin Indian Community
- Fort Sill Apache Tribe
- Pascua Yaqui Tribe
- Tohono O'odham Nation

4.5 Section 106 Consultation

Section 106 consultation was initiated by the Tonto National Forest and the SHPO on March 31, 2017, and the ACHP on December 7, 2017. A Programmatic Agreement is being drafted with the Tonto National Forest, Arizona SHPO, ACHP, Resolution Copper, ASLD, BLM, USACE, and tribes. The PA will be a signed and legally binding document to ensure cultural and historical resources are protected and managed in a predetermined manner with those involved.

Beginning in 2018, multiple meetings have been held with interested parties and those who would be signatories of the document. The draft PA is provided as appendix O of this EIS. A final PA will be signed and completed prior to publication of the FEIS.

4.6 Other Agency Consultation

Section 7 consultation will occur after a preferred alternative is selected and would involve the Tonto National Forest, the U.S. Fish and Wildlife Service, and other land management agencies (ASLD or BLM) as applicable, depending on the final arrangement of land in the preferred alternative.

4.7 Tonto National Forest Tribal Monitor Cultural Resources Program and Emory Oak Restoration Studies

4.7.1 Tribal Monitor Program

As a result of input received during ongoing consultation between the Tonto National Forest and participating tribes, the Tonto National Forest agreed to initiate, and Resolution Copper agreed to fund, a unique program that would employ tribal members as auxiliary specialists to assist cultural resources staff and proponent-contracted archaeologists in surveying lands proposed for development as part of the project (i.e., lands proposed for development either as component facilities of the Resolution Copper GPO or as EIS alternative facility locations). In particular, the goal of this program is to provide the tribes with greater opportunity to identify traditional ecological knowledge places (TEKPs) and other tribal resources that are likely not to be recognized by non-Native archaeologists.

The Tonto National Forest conducted an initial tribal monitor training session from January 25 through February 2, 2018, and tribal members began accompanying contracted cultural resource survey crews in March 2018. A second training of additional tribal members was held between October 1 and October 10, 2018, to enable representation of additional tribes in survey efforts. Fifty-four tribal members completed the training between the two 2018 sessions. The tribal monitors will survey each project component in addition to Class III survey to ensure not only archaeological information, but tribal perspectives are understood and documented. This work is ongoing and may include additional training for tribal monitors to assist with other resource surveys.

The tribal monitors have already proven highly effective in identifying areas, resources, and sites of importance to the four cultural groups with ties to the area (Apache, O’odham, Puebloan, and Yavapai), including springs and seeps, plant and mineral resource collecting areas, landscapes and landmarks, caches of regalia and human remains, and other sites. The tribal monitors have not only surveyed new alternative tailings locations, but also revisited the Near West tailings location and Oak Flat to evaluate the areas based on their tribal perspectives.

4.7.2 Emory Oak Restoration

As noted in chapter 1, in December 2014, Congress passed the Carl Levin and Howard P. ‘Buck’ McKeon National Defense Authorization Act for Fiscal Year 2015 (NDAA), which included as Section 3003 the “Southeast Arizona Land Exchange and Conservation Act of 2011.” Under this legislatively mandated land exchange, Resolution Copper would receive lands containing the Oak Flat Campground east of the town of Superior, which is a known historical and current Emory oak acorn gathering location for the Apache and Yavapai.

As stated in the Southeast Arizona Land Exchange and Conservation Act, the Tonto National Forest and Resolution Copper are to address the concerns of Indian Tribes. Because the tribes have expressed concern about the Emory oak grove at Oak Flat, Resolution Copper has committed to funding Forest Service efforts to restore Emory oak at suitable locations elsewhere in Arizona, particularly within the “Four Forests Restoration Initiative” (4FRI) project areas, consisting of the Kaibab, Coconino, Apache-Sitgreaves, and Tonto National Forests.

The initial 5-year phase of the Emory oak restoration program, which began in fall 2018, lays out a series of goals for each year of the program. The following is a highly summarized listing of the detailed program goals that have been set forth and agreed upon by both the Forest Service and the participating tribes.

- The first year will consist of initial meetings and field visits between the Forest Service and tribal representatives to identify existing areas that have been used to collect acorn; groves that could potentially be treated and developed for acorn harvesting; and selection of up to six existing or potential oak grove sites for further study of their feasibility for restoration as future tribal acorn-gathering locations.
- The second year (beginning in fall 2019) will develop and implement treatment plans to improve the selected oak groves, based on the ongoing research. Treatments designed by the project team may include erecting fences, removing brush, burning understory, transplanting oak seedlings, landscaping to ensure groves receive adequate water, and other measures.
- The third and fourth years (fall 2020, fall 2021) will consist of monitoring treated groves and developing recommendations on the efficacy and any modifications of the treatments. Field visits will be arranged for elders and youth to participate in traditional activities, including acorn harvesting.
- The fifth year will consist of continued monitoring and harvesting, and developing a report to document the procedures used, the results of the treatments, and recommendations for management protocols that may preserve Emory oaks on forests where this resource is critical to culturally affiliated tribes.

4.8 Cooperating Agencies

CEQ regulations (40 CFR 1508.5) define a cooperating agency as any Federal agency (other than the lead agency) and any State or local agency or Indian Tribe with jurisdictional authority or special expertise with respect to any environmental impact involved in a proposal. The cooperating agencies that assisted in preparation of this EIS are listed and their respective jurisdictional authorities or areas of special expertise are described in chapter 1, section 1.6.3; for convenience, the nine participating agencies are also identified in the accompanying text box. These agencies assisted with EIS preparation in a number of ways, including conducting or providing studies and inventories, reviewing baseline condition reports, identifying issues, assisting with the formulation of alternatives, and reviewing preliminary DEIS text and other EIS materials.

Cooperating Agencies for the Resolution Copper Project and Land Exchange EIS

- Arizona Department of Environmental Quality
- Arizona Department of Water Resources
- Arizona Game and Fish Department
- Arizona State Land Department
- Arizona State Mine Inspector
- Bureau of Land Management
- Pinal County Air Quality Control District
- U.S. Army Corps of Engineers
- U.S. Environmental Protection Agency

Not all of the cooperating agencies have participated in all aspects of the EIS preparation. Early in the cooperating agency process, each agency conferred with the Tonto National Forest and agreed to a carefully defined role and set of responsibilities in relation to the Resolution Copper Project and Land Exchange that aligned with that agency's unique jurisdictional authority or area(s) of special expertise. Individualized Memoranda of Understanding defining these roles and

responsibilities were thereafter signed by representatives of both the Forest Service and of each of the agencies listed in the text box.

The Tonto National Forest also engaged several other agencies, though those agencies ultimately did not become cooperating agencies or participate in the preparation of the DEIS. The NEPA team had sited early versions of the Peg Leg alternative on lands along the Gila River that previously had been withdrawn on behalf of the U.S. Bureau of Reclamation for potential future water projects. Ultimately, the Peg Leg alternative was resituated off of any parcels associated with the U.S. Bureau of Reclamation, but interim discussions were held with the U.S. Bureau of Reclamation to discuss the regulatory process and decision framework. The U.S. Bureau of Reclamation also was consulted regarding a separate NEPA process being undertaken for the reallocation of CAP non-Indian agriculture water contracts, including a possible allocation to Resolution Copper. The Tonto National Forest and U.S. Bureau of Reclamation determined that the non-Indian agriculture reallocation was already undergoing a separate NEPA analysis and did not need to be included in the proposed action for this EIS, although it is considered a reasonably foreseeable future action and considered for cumulative effects.

The Tonto National Forest engaged the USGS early in the groundwater modeling process, and discussed the potential for the USGS to be involved in various technical aspects of the project involving geological, geotechnical, or hydrologic analyses. Ultimately, the USGS declined involvement, though specialists attended early meetings of the Groundwater Modeling Workgroup. The San Carlos Apache Tribe also indicated interest in participating in the Groundwater Modeling Workgroup, and a representative attended a number of Groundwater Modeling Workgroup meetings.

4.9 Project Notifications to Other Federal, State, and County Agencies and Municipal Governments

In addition to project-related information provided to the nine cooperating agencies identified in section 4.8, each of the following Federal, State, County, and local governments and agencies has been and will continue to be provided with regular updates and other notifications regarding the project NEPA process.

4.9.1 Federal

- Advisory Council on Historic Preservation
- U.S. Bureau of Reclamation
- U.S. Fish and Wildlife Service
- U.S. House of Representatives
- U.S. Senate

4.9.2 State

- Arizona Department of Transportation
- Arizona Geological Survey
- Arizona Governor
- Arizona State Board of Regents
- Arizona State Parks (Arizona State Historic Preservation Office)

4.9.3 County

- Coconino County
- Gila County Board of Supervisors
- Gila County Planning and Zoning
- Graham County Board of Supervisors
- Maricopa County
- Pima County
- Pima County Board of Supervisors
- Pinal County Board of Supervisors
- Pinal County Public Works
- Santa Cruz County
- Yavapai County

4.9.4 Local

- Cave Creek Council
- City of Chandler
- City of Globe
- City of Mesa
- City of Phoenix
- Superior Police
- Superior Schools
- Town of Benson
- Town of Carefree
- Town of Hayden
- Town of Kearny
- Town of Mammoth
- Town of Miami
- Town of Paradise Valley
- Town of Patagonia
- Town of Payson
- Town of Queen Creek
- Town of Sierra Vista
- Town of Superior
- Town of Winkelman

4.9.5 Tribal

- Ak-Chin Indian Community
- Fort McDowell Yavapai Nation
- Fort Sill Apache Tribe
- Gila River Indian Community
- Hopi Tribe
- Mescalero Apache Tribe
- Pascua Yaqui Tribe
- Pueblo of Zuni
- Salt River Pima-Maricopa Indian Community
- San Carlos Apache Tribe
- Tohono O’odham Nation
- Tonto Apache Tribe
- White Mountain Apache Tribe
- Yavapai-Apache Nation
- Yavapai-Prescott Indian Tribe

CHAPTER 5

List of Preparers

5.1 List of Preparers

The Resolution Copper Project and Land Exchange EIS was prepared under the supervision of the Forest Service. The individuals who contributed to the preparation of this document are listed here by organization, along with their education, years of experience, and project role (tables 5.1.1-1 and 5.1.2-1).

5.1.1 Forest Service

Table 5.1.1-1. Forest Service personnel participating in the EIS

Name	Degree	Years of Experience	Project Role
Lee Ann Atkinson	M.S., Geology-Geophysics	15	NEPA Coordinator - Minerals
Allison Borchers	Ph.D., Economics	8	Socioeconomics/ Environmental Justice
Paul “Pablo” Burghard - retired		6	Recreation/Trails
Clarence Coffey	Occupational Safety and Health Professional; EPA Certified Lead Renovator	32	Public Health and Safety
Chris Crawford	B.S., Civil Engineering	26	Transportation/Noise
Edward Gazzetti	M.S., Geological Sciences	5	Hydrogeology
Joe Gurrieri	M.S., Geology	33	Hydrogeology
Benjamin “Chad” Harrold	M.S., Geology	8	Geology
Kristina Hill	M.A., Anthropology	18	Cultural Resources
Ana Ingstrom	M.S., Mining Engineering	7	Mining Engineering
Brad Johnson	Over 50 U.S. Forest Service training courses in Fuels and Fire Management	18	Fuels/Fire Management
Alex Mankin	M.S., Geology	6	Geology
Mark McEntarffer	B.S., Public Planning	19	Lands

continued

Table 5.1.1-1. Forest Service personnel participating in the EIS *(cont'd)*

Name	Degree	Years of Experience	Project Role
Maria McGaha	M.S., Hazardous Waste Management, M.B.A., Business Administration	19	Lands
Christina Milos	Ph.D., Landscape Architecture	5	ID Team Lead/Env. Planning
Chandler Mundy	B.S., Rangeland Resources	13	Rangeland Management
Mark Nelson	Ph.D., Natural Resources andScience Management		Project Manager (2014-2016)
Nanebah Nez-Lyndon	M.A., Anthropology	10	Tribal Liaison
Greg Olsen	B.S., Environmental Earth Science	29	Hydrology
Devin Quintana	B.S., Regional Development	15	Public Services Program Manager
Mary Rasmussen	M.S., Forest Ecology	32	Project Manager (2017 – Present)
Judd Sampson	B.S., Geological Science	7	Geology/Minerals Administration
John Scaggs	B.A., Mass Communications	35	Public Affairs Specialist
Greg Schuster	M.S., Natural Resource Management	23	Recreation
David Sheehan	M.A., Landscape Architecture	4	Scenery/Recreation
Timothy Stroope	Ph.D., Geoscience	11	Hydrogeology
Mark Taylor	B.S., Wildlife Management	22	Botany/Wildlife Biology
Carrie Templin	B.S., Natural Resource Recreation	27	Public Affairs Officer
Marianne Thomas	M.S., Human Dimensionsof Ecosystem Science and Management	11	NEPA Review Coordinator
Andrea "Jamie" Wages	B.S., Rangeland Resources	11	Rangeland Management
Peter Werner	M.S., Mining Engineering	33	Mine Engineering/Reclamation
Scott Williams	B.S., Environmental Studies and Fire Management	29	Air Quality

Source: Morey and Ritter (2016)

5.1.2 Third-Party NEPA Contractors

Table 5.1.2-1. Third-party NEPA contractor personnel participating in the EIS

Name	Degree	Years of Experience	Project Role
Jenny Addy (SWCA)	B.S., Conservation and Restoration Ecology	6	Range
Victoria Amato (SWCA)	M.S., Forestry, emphasis Fire Ecology/Habitat Management; M.S., Resource Management	12	Fire Management
Mandy Bengtson Williams (SWCA)	Ph.D., Geoscience	14	Reclamation/ Revegetation
Victoria Boyne (SWCA)	B.A., Sociology	11	Literature Cited/Project Record
Terry Chute (SWCA)	A.S., Forest Technology	36	Senior Forest Service NEPA Advisor
Charles Coyle (SWCA)	M.A., English	25	Deputy Project Manager
Danielle Desruisseaux (SWCA)	B.A., Anthropology	32	Technical Editing
Meggan Dugan (SWCA)	M.A.S., Geographic Information Systems	5	GIS, Hazardous Materials, Socioeconomics
Chris Garrett (SWCA)	B.S., Hydrology	23	Project Manager
Eleanor Gladding (SWCA)	M.S., Biology e. Herpetology	27	Wildlife/Botany
Jill Grams (SWCA)	M.L.A., Landscape Architecture e. Environmental Planning	19	Scenery/Recreation
Suzanne Griset (SWCA)	Ph.D., Anthropology e. North American Archaeology	38	Cultural Resources
Chris Horyza (SWCA)	B.S., Forestry and Range Management e. Agriculture	37	Senior BLM NEPA Advisor
Ken Houser (SWCA)	M.A., Geology	33	Principal in Charge
Jeff Johnson (SWCA)	M.S., Plant Biology	12	Wildlife/Botany
Charles Kliche (SWCA)	Ph.D., Mining Engineering	44	Mine Engineering
Jerryll Moreno (SWCA)	M.A., Anthropology; Scholarly Publishing Certification	26	Publication Layout and Design; Graphics; Technical Editing
Donna Morey (SWCA)	B.A., Urban Planning	10	Assistant Project Manager; Project Controller
Emily Newell (SWCA)	B.S., Environmental Science and Natural Restoration	2	Project Logistics
Heidi Orcutt-Gachiri (SWCA)	Ph.D., Linguistics and Anthropology	20	Managing Editor
Kimberly Proa (SWCA)	A.A., Anthropology	12	Publication Formatter
Ryan Rausch (SWCA)	M.E.L.P., Environmental Law Policy and Conservation	13	Scenery/Recreation

continued

Table 5.1.2-1. Third-party NEPA contractor personnel participating in the EIS *(cont'd)*

Name	Degree	Years of Experience	Project Role
DeAnne Rietz (SWCA)	M.S., Watershed Management	17	Hydrology/Soils
Jonathan Rigg (SWCA)	M.A., Russian and Slavic Studies	9	Environmental Justice; Public Health and Safety; Socioeconomics
Steve Rinella (SWCA)	B.S., Forestry	35	Lands
Brad Sohm (SWCA)	B.S., Chemical Engineering e. Environmental Engineering	14	Ecology/Climate Change
Adrienne Tremblay (SWCA)	Ph.D., Anthropology	12	Cultural Resources
Scott Woods (SWCA)	B.S., Geography: Environmental Planning and GIS e. Landscape Arch/Urban Planning	25	GIS
Jennifer Wynn (SWCA)	M.P.P., Environmental Policy	8	Revegetation
Jamie Young (SWCA)	B.S., Biology	17	Wildlife/Botany
Doug Jeavons (BBC Research & Consulting)	M.A., Economics	28	Socioeconomics
Mike Verdone (BBC Research & Consulting)	Ph.D., Natural Resource and Environmental Economics	13	Socioeconomics
Diana Cook (BGC Engineering)	Ph.D., Geological Engineering	12	Mine Engineering
Robert "Nick" Enos (BGC Engineering)	M.Sc., Geosciences	27	Geology/Environmental Science
Gaston Gonzales (BGC Engineering)	M.S., Geomechanics	19	Geology/Geotechnical
Mike Henderson (BGC Engineering)	M.S., Civil Engineering	33	Mine Engineering
Derek Hrubes (BGC Engineering)	B.Sc., Civil Engineering	13	Alternatives Engineering Support
Amir Karami (BGC Engineering)	Ph.D., Rock Mechanics	20	Rock Mechanics
Elliott Matthews (BGC Engineering)	B.Sc., Geological Engineering	8	Alternatives Engineering Support
Troy Meyer (BGC Engineering)	B.S., Civil Engineering	23	Mine Engineering
Tony Monasterio (BGC Engineering)	B.S., Geological Engineering	9	Alternatives Engineering Support
Gabriele Walser (BGC Engineering)	Ph.D., Civil Engineering	30	Hydrology and Surface Water
Hamish Weatherly (BGC Engineering)	M.Sc., Geological Sciences	22	Hydrology/Soils
Nancy Ashton (DOWL)	Professional Development Classes	20	Engineering/Noise
Laurie Brandt (DOWL)	M.S., Remote Sensing	21	Minerals
Todd Cormier (DOWL)	B.S., Civil Engineering	26	Mine Engineering/ Transportation

continued

Table 5.1.2-1. Third-party NEPA contractor personnel participating in the EIS *(cont'd)*

Name	Degree	Years of Experience	Project Role
Zaid Hussein (BGC Engineering)	M.S., Civil Engineering	11	Noise/Transportation Engineer
Rudy Ing (DOWL)	M.B.A., Business Administration	31	Sr. Civil Engineer
Sara Nicolai (DOWL)	B.A., Civil Engineering	11	Mine Engineering/ Transportation
Sarah Patterson (DOWL)	M.S., Civil Engineering	10	Transportation/Traffic
Mark Williamson (Geochemical Solutions, LLC)	Ph.D., Geochemistry	27	Hydrology/Soils
Rex Bryan (GeoStat Systems LLC)	Ph.D., Mineral Economics	38	Geology
Joe Frank (HydroGeo, Inc.)	M.S., Geological Science	41	Hydrology/Soils
Fernando Fuentes Moccia (NCL)	Civil Mining Engineering	40	Mine Engineering
Deepak Malhotra (Resource Development Inc.)	Ph.D., Mineral Economics	44	Mine Engineering
Marty Rozelle (Rozelle Group)	Ph.D., Community Education and Management	36	Public Involvement
Bruce Macdonald (SLR International Corporation)	Ph.D., Atmospheric Science	41	Air Quality

Source: Morey and Ritter (2016)

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CHAPTER 7

Glossary, Acronyms, and Abbreviations

7.1 Glossary

Glossary

Acid-forming materials	Earth materials that contain sulfide minerals or other materials that, if exposed to air, water, or weathering processes, form acids that may create acid drainage (as in potentially acid generating or reactive rock).
Acid mine drainage	1. Drainage with a pH of 2.0 to 4.5 from mines and mine wastes. It results from the oxidation of sulfides exposed during mining, which produces sulfuric acid and sulfate salts. The acid dissolves minerals in the rocks, further degrading the quality of the drainage water. 2. Acidic run-off water from mine waste dumps and mill tailings ponds containing sulfide minerals. Also refers to groundwater pumped to surface from mines.
Apex tunnel	An existing structure at the West Plant Site that diverts off-site flows from north of the site to the Silver King Wash west of the site.
Apron feeder	A metal conveyor (or conveyor with metal plates) operated to control the rate of delivery to a standard belt conveyor. The metal-plate construction allows the apron feeder to withstand the weight and force of rock material being dumped from a chute onto a bin.
Belt tilter	A mechanism on a belt conveyor that allows material to be discharged into a bin or silo.
Cave	Caving of the ore is induced by undercutting the ore zone, which removes its ability to support the overlying rock material. Fractures spread throughout the area to be extracted, causing it to collapse and form a cave underground, which propagates upward throughout the mining process.
Civilian Conservation Corps	The Civilian Conservation Corps (CCC) was a public work relief program that operated from 1933 to 1942 in the United States for unemployed, unmarried men. The CCC was a major part of President Franklin D. Roosevelt's New Deal, which provided unskilled manual labor jobs related to the conservation and development of natural resources in rural lands owned by Federal, State, and local governments.
Crosscut	A passageway driven at an angle to the drifts of a mine. The crosscuts connect the parallel drifts.
Crushers	Machines that reduce large rocks into smaller rocks.
Cyclone tailings	Hydrocyclone classifiers (cyclones) would process both ore and tailings. The centrifugal force separates the tailings into both fines deposited into the tailings facility and sand which is used in embankment raises.
Diurnal	A rhythm to each day; in biology, being active or open during the day.
Drift	A horizontal or nearly horizontal underground opening.
Dry	A change house for mine workers. Contains lockers and clothes baskets and is equipped with shower, toilets, and sinks.

continued

Glossary

East Plant Site	Current exploratory shaft sinking site, historic Magma Mine site, future mine site, and area impacted by block caving.
Fire intensity	Fire intensity refers to the rate at which a fire produces heat at the flaming front and should be expressed in terms of temperature or heat yield.
Fire severity	Fire severity is a measure of the physical change in an area caused by burning.
Flotation	Process of separating small particles of various materials by treatment with chemicals in water in order to make some particles adhere to air bubbles and rise to the surface for removal while others remain in the water.
Fracture limit	The fracture limit is the outer limit of any potential large-scale surface cracking (or fracturing) that consists of an area around the cave crater in which the ground surface could be broken with open tension cracks and rotational blocks.
Galloway	Temporary working platform suspended above the bottom of the shaft under construction, to support the ongoing drilling, blasting, and mucking.
Gangue	Commercially worthless material that surrounds, or is closely mixed with a wanted mineral in an ore deposit.
Graben	An elongated block of the earth's crust lying between at least two faults and displaced downward relative to the blocks on either side.
Grizzly	A coarse screening or scalping device that prevents oversized bulk material from entering a material transfer system, such as an ore pass or ore chute. A grizzly is typically constructed of rails, bars, or steel beams.
Historic property	As defined in the implementing regulations of Section 106, 36 CFR 800.16(l), historic properties are any district, site, building, structure, or object that is included in or eligible for inclusion in the NRHP under one of four significance criteria: a) association with events that have made a significant contribution to the broad patterns of history; b) association with a significant person in the past; c) embodiment of the distinctive characteristics of a type, period, or method of construction, or represents the work of a master or possess high artistic values; d) the potential to yield information important about the past (National Park Service 1995).
Loadout facility	A proposed facility where copper concentrate would be filtered to remove water and then sent to off-site smelters via rail cars or trucks.
MARRCO corridor	Magma Arizona Railroad Company railroad corridor that begins at the Union Pacific Line at Magma Junction and continues to the town of Superior. The corridor would be used for water pipelines, concentrate pipelines, power and pump stations.
MARRCO right-of-way	The existing easement through public and private property associated with the MARRCO railway.
Mineralization	The process or processes by which a mineral or minerals are introduced into a rock, resulting in a valuable or potentially valuable deposit. It is a general term, incorporating various types; e.g., fissure filling, impregnation, and replacement.

continued

Glossary

New Magma Irrigation and Drainage District (NMIDD)	An irrigation and water conservation district located west of Phoenix, between Queen Creek and the Gila River. It encompasses 27,410 acres, of which 26,900 are irrigable.
Ore	The naturally occurring material from which a mineral or minerals of economic value can be extracted at a reasonable profit.
Panel caving	A high-volume underground mining technique. A variation of block caving, typically used on low-grade, massive ore bodies.
Semi-autogenous grinding (SAG)	A type of grinding mill designed to break a solid material into smaller pieces. It is essentially autogenous but uses some balls to aid in grinding steel.
Semi-autonomous	Equipment with instrumentation and computer controls to be operated with minimal or no manual oversight.
Sensitive receptor	Those locations or areas where dwelling units or other fixed, developed sites of frequent human use occur.
Skip	A bucket used to hold broken ore and development rock that is hoisted from a mine via a shaft.
Slot raise	A shaft driven upward from a lower level to a higher level.
Slurry	Mixture of a fine-grained solid material – such as copper ore concentrate or tailings - and water.
Store and release cover	A reclamation cover that minimizes infiltration into the underlying material by acting like a sponge to store water from precipitation events until it is evaporated or transpired by plants growing in the cover material.
Subsidence	The process by which underground excavation collapses and movement of material connects all the way to the surface where a depression or deformation in the land surface is formed.
Sulfide enrichment	Enrichment of a deposit by replacement of one sulfide by another of high value, as pyrite by chalcocite.
Tailings	The processed waste component that results from copper ore processing.
Tailings (PAG)	The tailings produced in the copper-molybdenum potentially acid generating (PAG) circuit.
Tailings (NPAG)	The tailings product that would be produced from rougher/non-potentially acid generating (NPAG) circuit.
Tailings corridor	The corridor that begins at the West Plant Site and ends at the tailings storage facility and is used for water and tailings pipelines and access.

continued

Glossary

Tailings Storage Facility	The final storage area for unrecoverable and uneconomic metals, minerals, chemicals, organics and process water.
Traditional Ecological Knowledge (TEK)	Cumulative body of knowledge, practice, and belief, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment.
Waste Rock	Valueless rock that must be fractured and removed from a mine to keep the mining scheme practical and gain access to ore.
Water (CAP)	This water is the fresh make-up water that is drawn either directly from the Central Arizona Project (CAP) canal or through pumping of groundwater available through banking of CAP credits.
Water (effluent)	Wastewater (treated or untreated) that flows out of a treatment plant, sewer, or industrial outfall.
Water (filtrate)	The water removed from the concentrate filtration process.
Water (mine dewatering)	Groundwater that accumulates in underground mine workings and must be pumped out in order to operate the mine.
Water (mine service)	Water used at the mine for the refrigeration and ventilation systems, dust suppression, washdown water, and direct cooling.
Water (potable)	Potable water is defined as “water that meets the standards for drinking purposes of the State of Arizona and those of the US Environmental Protection Agency’s National Primary Water Regulations.” This water is kept completely separate from the other waters, and is supplied by Arizona Water Company.
Water (process)	Water which comes into direct contact with or results from the production or use of any raw material, intermediate product, finished product, byproduct, or waste product. The project creates this through milling, grinding, thickener overflows, and other mine processes. Other types of water that come into contact with process water by mixing into the process water pond or at the tailings distribution box are considered process water from that point forward. Process water is reused and recycled to the greatest extent possible within the mill area. Ore moisture is considered a process water due to its contact with raw materials.
Water (reclaim)	Decanted water pumped from a set of barges in the tailings storage facility to the process water pond. Includes tailings storage facility stormwater runoff and tailings storage facility seepage captured by seepage collection embankments.
Water (service)	Fresh water stored at the CAP water distribution tank, used in several ways at the concentrator complex. It is used for dust suppression and wash-down water, as well as for gland water.
Water (void)	The tailings consist of a matrix of solid waste material and water. This water, which fills the annular spaces between the solid particles, is called void water.
West Plant Site	Current site of water treatment plant, historic Magma Mine concentrator and smelter, legacy tailings/waste rock, future site of concentrator.

7.2 Acronyms and Abbreviations

Acronyms and Abbreviations

°C	degree(s) Celsius
°F	degree(s) Fahrenheit
|C|	absolute contrast threshold
ΔE	color contrast for gray terrain
µg	microgram(s)
µg/m³	micrograms per cubic meter
A	
ACEC	Area of Critical Environmental Concern
ACHP	Advisory Council on Historic Preservation
Act	Southeast Arizona Land Exchange and Conservation Act
ADEQ	Arizona Department of Environmental Quality
ADOT	Arizona Department of Transportation
ADWR	Arizona Department of Water Resources
AGFD	Arizona Game and Fish Department
AIRFA	American Indian Religious Freedom Act of 1978
Air Sciences	Air Sciences Inc.
AMA	Active Management Area
amsl	above mean sea level
ANCOLD	Australian National Committee on Large Dams
APP	Aquifer Protection Permit
APS	Arizona Public Service Company
Arizona Trail	Arizona National Scenic Trail
ARS	Arizona Revised Statutes
ASLD	Arizona State Land Department
ATV	all-terrain vehicle
AUM	animal unit month
AWQS	Arizona Numeric Aquifer Water Quality Standards
AZPDES	Arizona Pollutant Discharge Elimination System
B	
BADCT	Best Available Demonstrated Control Technology
BGC Engineering	BGC Engineering USA Inc.
BGEPA	Bald and Golden Eagle Protection Act
BLM	U.S. Department of the Interior Bureau of Land Management
C	
CAP	Central Arizona Project
CAP Water	Fresh make-up water that is drawn either directly from the Central Arizona Project (CAP) canal or through pumping of groundwater available through banking of CAP credits
CDA	Canadian Dam Association
CDP	Census designated place
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
cfs	cubic feet per second
CO	carbon monoxide
CWA	Clean Water Act
CWPP	Community Wildfire Protection Plan
D	
DAT	Deposition Analysis Thresholds
dB	decibel(s)
dBA	A-weighted decibel(s)
dBL	unweighted decibel(s)
DEIS	draft environmental impact statement

continued

Acronyms and Abbreviations

E	
EA	environmental assessment
EIS	environmental impact statement
EO	executive order
EPA	U.S. Environmental Protection Agency
ERMA	Extensive Recreation Management Area
ERU	Ecological Response Unit
ESA	Endangered Species Act
ET	evapotranspiration
F	
FEIS	final environmental impact statement
FEMA	Federal Emergency Management Agency
FLPMA	Federal Land Policy and Management Act
FMEA	failure modes and effects analysis
FONSI	Finding of No Significant Impact
forest plan	Tonto National Forest Land and Resource Management Plan
Forest Service	U.S. Department of Agriculture Forest Service
FR	fire regime
FSH	Forest Service Handbook
FSM	Forest Service Manual
FWS	U.S. Department of the Interior Fish and Wildlife Service
FY	fiscal year
G	
g/ha/year	grams per hectare per year
Ga	billion years old
GDE	groundwater-dependent ecosystem
GIS	geographic information system
GMU	Game Management Unit
GPO	General Plan of Operations
GTES	General Terrestrial Ecosystem Survey
H	
H_2SO_4	sulfuric acid
HAP	hazardous air pollutant
HDD	horizontal directional drilling
HDMS	Arizona Heritage Data Management System
HDPE	high-density polyethylene
HPTP	historic properties treatment plan
I	
ICMM	International Council on Mining and Metals
ID	interdisciplinary
IMPLAN	Impact Analysis for Planning
in/sec.	inches per second
ISO	Insurance Services Office
ITRB	Independent Technical Review Board
K	
Kg TNTe	kilograms TNT equivalent
km	kilometer(s)
KOP	key observation point
kV	kilovolt(s)
L	
L	liter(s)
land exchange	Southeast Arizona Land Exchange
Ldn	day-night average noise level
Leq	energy average noise level
Leq(h)	energy average hourly noise level
Lmax	maximum noise level
LOS	level of service

continued

Acronyms and Abbreviations

LOST	Legends of Superior Trails
M	
m	meter(s)
MA	Management Area
Ma	million years old
MAC	Mining Association of Canada
MARRCO	Magma Arizona Railroad Company
MBSC	Migratory Bird Species of Concern
MBTA	Migratory Bird Treaty Act
mg/L	milligram(s) per liter
MIS	Management Indicator Species
MM	Modified Mercalli
MOA	memorandum of agreement
mph	miles per hour
MSGP	Multi-Sector General Permit
MSHA	Mine Safety and Health Administration
N	
N	nitrogen
N/A	not available, not applicable
NAAQS	National Ambient Air Quality Standards
NAGPRA	Native American Graves Protection and Repatriation Act of 1990
NDAA	the Carl Levin and Howard P. ‘Buck’ McKeon National Defense Authorization Act for Fiscal Year 2015
NEPA	National Environmental Policy Act of 1969, as amended
NFS	National Forest System
NFS Road	National Forest System Road
NGO	non-governmental organization
NHPA	National Historic Preservation Act
NIBS	National Institute of Building Sciences
NMIDD	New Magma Irrigation and Drainage District
NNP	net neutralizing potential
NO_2	nitrogen dioxide
NO_x	nitrogen oxides
NOI	Notice of Intent
NPAG	non-potentially acid generating
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Properties
NSDWR	National Secondary Drinking Water Regulations
O	
Oak Flat Withdrawal Area	Oak Flat Picnic and Campground Withdrawal Area
OHV	off-highway vehicle
OSI	Other Species of Interest
P	
PA	programmatic agreement
PAG	potentially acid generating
PBRISD	Performance-Based Risk-Informed Safe Design
PCAQCD	Pinal County Air Quality Control District
PCE	primary constituent element
PL	Public Law
$PM_{2.5}$	particulate matter 2.5 microns in diameter or smaller
PM_{10}	particulate matter 10 microns in diameter or smaller
ppm	part(s) per million
PPV	peak particle velocity
project	Resolution Copper Project and Land Exchange
PSD	prevention of significant deterioration
Q	
Q/D	Standard Source/Distance

continued

Acronyms and Abbreviations

R	
REC	recognized environmental condition
Resolution Copper	Resolution Copper Mining, LLC
RFFA	reasonably foreseeable future action
RI	Report of Investigations
ROD	record of decision
ROS	recreation opportunity spectrum
RUG	Recreation User Group
S	
S	sulfur
SCC	Species of Conservation Concern
SERI	Species of Economic and Recreational Importance
SGCN	Species of Greatest Conservation Need
SHPO	Arizona State Historic Preservation Office
SIP	State Implementation Plan
SMA	Special Management Area
SO_2	sulfur dioxide
SR	Arizona State Route
SRMA	Special Recreation Management Area
SRP	Salt River Project
SSURGO	Soil Survey Geographic
SWCA	SWCA Environmental Consultants
SWPPP	stormwater pollution prevention plan
SWReGAP	Southwest Regional Gap Analysis Project
T	
TCP	traditional cultural property
TEKP	traditional ecological knowledge place
TNF	Tonto National Forest
Town	Town of Superior
U	
U.S.	United States
U.S. 60	U.S. Route 60
USACE	U.S. Army Corps of Engineers
U.S.C.	United States Code
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Service
UTV	utility task vehicle
V	
VdB	vibration decibel(s)
VOC	volatile organic compound
VQO	Visual Quality Objective
VRM	Visual Resource Management
W	
WUI	wildland urban interface

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APPENDIX A. SECTION 3003 OF THE NDAA

NDAA Section 3003

Sec. 3003 Southeast Arizona Land Exchange and Conservation.

(a) PURPOSE. – The purpose of this section is to authorize, direct, facilitate, and expedite the exchange of land between Resolution Copper and the United States.

(b) DEFINITIONS. – In this section:

(1) APACHE LEAP. – The term “Apache Leap” means the approximately 807 acres of land depicted on the map entitled “Southeast Arizona Land Exchange and Conservation Act of 2011-Apache Leap” and dated March 2011.

(2) FEDERAL LAND. – The term “Federal land” means the approximately 2,422 acres of land located in Pinal County, Arizona, depicted on the map entitled “Southeast Arizona Land Exchange and Conservation Act of 2011-Federal Parcel-Oak Flat” and dated March 2011.

(3) INDIAN TRIBE. – The term “Indian tribe” has the meaning given the term in section 4 of the Indian Self-Determination and Education Assistance Act (25 U.S.C. 450b).

(4) NON-FEDERAL LAND. – The term “non-Federal land” means the parcels of land owned by Resolution Copper that are described in subsection (d)(1) and, if necessary to equalize the land exchange under subsection (c), subsection (c)(5)(B)(i)(I).

(5) OAK FLAT CAMPGROUND. – The term “Oak Flat Campground” means the approximately 50 acres of land comprising approximately 16 developed campsites depicted on the map entitled “Southeast Arizona Land Exchange and Conservation Act of 2011-0ak Flat Campground” and dated March 2011.

(6) OAK FLAT WITHDRAWAL AREA. – The term “Oak Flat Withdrawal Area” means the approximately 760 acres of land depicted on the map entitled "Southeast Arizona Land Exchange and Conservation Act of 2011-0ak Flat Withdrawal Area” and dated March 2011.

(7) RESOLUTION COPPER. – The term “Resolution Copper” means Resolution Copper Mining, LLC, a Delaware limited liability company, including any successor, assign, affiliate, member, or joint venturer of Resolution Copper Mining, LLC.

(8) SECRETARY. – The term “Secretary” means Secretary of Agriculture.

(9) STATE. – The term “State” means the State of Arizona.

(10) TOWN. – The term “Town” means the incorporated town of Superior, Arizona.

(11) RESOLUTION MINE PLAN OF OPERATIONS. – The term “Resolution mine plan of operations” means the mine plan of operations submitted to the Secretary by Resolution Copper in November, 2013, including any amendments or supplements.

(c) LAND EXCHANGE. –

(1) IN GENERAL. – Subject to the provisions of this section, if Resolution Copper offers to convey to the United States all right, title, and interest of Resolution Copper in and to the non-Federal land, the Secretary is authorized and directed to convey to Resolution Copper, all right, title, and interest of the United States in and to the Federal land.

(2) CONDITIONS ON ACCEPTANCE. – Title to any non-Federal land conveyed by Resolution Copper to the United States under this section shall be in a form that-

A. is acceptable to the Secretary, for land to be administered by the Forest Service and the Secretary of the Interior, for land to be administered by the Bureau of Land Management; and

B. conforms to the title approval standards of the Attorney General of the United States applicable to land acquisitions by the Federal Government.

(3) CONSULTATION WITH INDIAN TRIBES. –

A. IN GENERAL. – The Secretary shall engage government-to-government consultation with affected Indian Tribes concerning issues of concern to the affected Indian tribes related to the land exchange.

B. IMPLEMENTATION. – Following the consultations under paragraph (A), the Secretary shall consult with Resolution Copper and seek to find mutually acceptable measures to-

i. address the concerns of the affect Indian tribes; and

ii. minimize adverse effects on the affected Indian tribes resulting from mining and related activities on the Federal land conveyed to Resolution Copper under this section.

(4) APPRAISALS. –

A. IN GENERAL. – As soon as practicable after the date of enactment of this Act, the Secretary and Resolution Copper shall select an appraiser to conduct appraisals of the Federal land and non-Federal land in compliance with the requirements of section 254.9 of title 36, Code of Federal Regulations.

B. REQUIREMENTS. –

i. IN GENERAL. – Except as provided in clause (ii), an appraisal prepared under this paragraph shall be conducted in accordance with national recognized appraisal standards, including –

I. the Uniform Appraisals Standards for Federal Land Acquisitions; and

II. the Uniform Standards of Professional Appraisal Practice.

ii. FINAL APPRAISED VALUE. – After the final appraised values of the Federal land and non-Federal land are determined and approved by the Secretary, Secretary shall not be required to reappraise or update the final appraised value –

I. for a period of 3 years beginning on the date of the approval by the Secretary of the final appraised value; or

II. at all, in accordance with section 254.14 of title 36, Code of Federal Regulations (or a successor regulation), after an exchange agreement is entered into by Resolution Copper and the Secretary.

iii. IMPROVEMENTS. – Any improvements made by Resolution Copper prior to entering an exchange agreement shall not be included in the appraised value of the Federal land.

iv. PUBLIC REVIEW. – Before consummating the land exchange under this section, the Secretary shall make the appraisals of the land to be exchange (or a summary thereof) available for public review.

C. APPRAISAL INFORMATON. – The appraisal prepared under this paragraph shall include a detailed income capitalization approach analysis of the market value of the Federal land which may be utilized, as appropriate, to determine the value of the Federal land, and shall be the basis for calculation of any payment under subsection (e).

(5) EQUAL VALUE LAND EXCHANGE. –

A. IN GENERAL. – The value of the Federal land and non-Federal land to be exchanged under this section shall be equal or shall be equalized in accordance with this paragraph.

B. SURPLUS OF FEDERAL LAND VALUE. –

i. IN GENERAL. – If the final appraised value of the Federal land exceeds the value of the non-Federal land, Resolution Copper shall –

I. convey additional non-Federal land in the State to the Secretary or the Secretary of the Interior, consistent with the requirements of this section and subject to the approval of the applicable Secretary;

II. make a cash payment to the United States; or

III. use a combination of the methods described in subclauses (I) and (II), as agreed to by Resolution Copper, the Secretary, and the Secretary of the Interior.

ii. AMOUNT OF PAYMENT. – The Secretary may accept a payment in excess of 25 percent of the total value of the land or interests conveyed, notwithstanding section 206(b) of the Federal Land Policy and Management Act of 1976 (43 U.S.C. 1716(b)).

iii. DISPOSITION AND USE OF PROCEEDS. – Any amounts received by the United States under this subparagraph shall be deposited in the fund established under Public Law 90-171 (commonly known as the "Sisk Act" 16 U.S.C. 484a) and shall be made available to the Secretary for the acquisition of land or interests in land in Region 3 of the Forest Service.

C. SURPLUS OF NON-FEDERAL LAND. – If the final appraised value of the non-Federal land exceeds the value of the Federal land –

i. the United States shall not make a payment to Resolution Copper to equalize the value; and

ii. except as provided in subsection (h), the surplus value of the non-Federal land shall be considered to be a donation by Resolution Copper to the United States.

(6) OAK FLAT WITHDRAWAL AREA. –

A. PERMITS. – Subject to the provisions of this paragraph and notwithstanding any withdrawal of the Oak Flat Withdrawal Area from the mining, mineral leasing, or public land laws, the Secretary, upon enactment of this Act, shall issue to Resolution Copper-

i. if so requested by Resolution Copper, within 30 days of such request, a special use permit to carry out mineral exploration activities under the Oak Flat Withdrawal Area from existing drill pads located outside the Area, if the activities would not disturb the surface of the Area; and

ii. if so requested by Resolution Copper, within 90 days of such request, a special use permit to carry out mineral exploration activities within the Oak Flat Withdrawal Area (but not within the Oak Flat Camp- ground), if the activities are conducted from a single exploratory drill pad which is located to reasonably minimize visual and noise impacts on the Campground.

B. CONDITIONS. – Any activities undertaken in accordance with this paragraph shall be subject to such reason- able terms and conditions as the Secretary may require.

C. TERMINATION. – The authorization for Resolution Copper to undertake mineral exploration activities under this paragraph shall remain in effect until the Oak Flat Withdrawal Area land is conveyed to Resolution Copper in accordance with this section.

(7) COSTS. – As a condition of the land exchange under this section, Resolution Copper shall agree to pay, without compensation, all costs that are –

A. associated with the land exchange and any environ- mental review document under paragraph (9); and

B. agreed to by the Secretary.

(8) USE OF FEDERAL LAND. – The Federal land to be conveyed to Resolution Copper under this section shall be available to Resolution Copper for mining and related activities subject to and in accordance with applicable Federal, State, and local laws pertaining to mining and related activities on land in private ownership.

(9) ENVIRONMENTAL COMPLIANCE. –

A. IN GENERAL. – Except as otherwise provided in this section, the Secretary shall carry out the land exchange in accordance with the requirements of the National Environmental Policy Act of 1969 (42 U.S.C. 4321 et seq.).

B. ENVIRONMENTAL ANALYSIS. – Prior to conveying Federal land under this section, the Secretary shall prepare a single environmental impact statement under the National Environmental Policy Act of 1969 (42 U.S.C. 4321 et seq.), which shall be used as the basis for all decisions under Federal law related to the proposed mine and the Resolution mine plan of operations and any related major Federal actions

significantly affecting the quality of the human environment, including the granting of any permits, rights-of-way, or approvals for the construction of associated power, water, transportation, processing, tailings, waste disposal, or other ancillary facilities.

C. IMPACTS ON CULTURAL AND ARCHAEOLOGICAL RESOURCES. – The environmental impact statement prepared under subparagraph (b) shall –

i. assess the effects of the mining and related activities on the Federal land conveyed to Resolution Copper under this section on the cultural and archeological resources that may be located on the Federal land; and

ii. identify measures that may be taken, to the extent practicable, to minimize potential adverse impacts on those resources, if any.

D. EFFECT. – Nothing in this paragraph precludes the Secretary from using separate environmental review documents prepared in accordance with the National Environmental Policy Act of 1969 (42 U.S.C. 4321 et seq.) or other applicable laws for exploration or other activities not involving –

i. the land exchange; or

ii. the extraction of minerals in commercial quantities by Resolution Copper on or under the Federal land.

(10) TITLE TRANSER. – Not later than 60 days after the date of publication of the final environmental impact statement, the Secretary shall convey all right, title, and interest of the United States in and to the Federal land to Resolution Copper.

(d) CONVEYANCE AND MANAGEMENT OF NON-FEDERAL LAND. –

(1) CONVEYANCE. – On receipt of title to the Federal land, Resolution Copper shall simultaneously convey-

A. to the Secretary, all right, title, and interest that the Secretary determines to be acceptable in and to –

i. the approximately 147 acres of land located in Gila County, Arizona, depicted on the map entitled “Southeast Arizona Land Exchange and Conservation Act of 2011-Non-Federal Parcel-Turkey Creek” and dated March 2011;

ii. the approximately 148 acres of land located in Yavapai County, Arizona, depicted on the map entitled “Southeast Arizona Land Exchange and Conservation Act of 2011-Non-Federal Parcel-Tangle Creek” and dated March 2011;

iii. the approximately 149 acres of land located in Maricopa County, Arizona, depicted on the map entitled “Southeast Arizona Land Exchange and Conservation Act of 2011-Non-Federal Parcel-Cave Creek” and dated March 2011;

iv. the approximately 640 acres of land located in Coconino County, Arizona, depicted on the map entitled “Southeast Arizona Land Exchange and Conservation Act of 2011-Non-Federal Parcel-East Clear Creek” and dated March 2011; and

v. the approximately 110 acres of land located in Pinal County, Arizona, depicted on the map entitled “Southeast Arizona Land Exchange and Conservation Act of 2011-Non-Federal Parcel-Apache Leap South End” and dated March 2011; and

B. to the Secretary of Interior, all rights, title, and interest that the Secretary of Interior determines to be acceptable in and to –

i. the approximately 3,050 acres of land located in Pinal County, Arizona, identified as “Lands to DOI” as generally depicted on the map entitled “Southeast Arizona Land Exchange and Conservation Act of 2011- Non-Federal Parcel-Lower San Pedro River” and dated July 6, 2011;

ii. the approximately 160 acres of land located in Gila and Pinal Counties, Arizona, identified as “Lands to DOI” as generally depicted on the map entitled “Southeast Arizona Land Exchange and Conservation Act of 2011-Non-Federal Parcel-Dripping Springs” and dated. July 6, 2011; and

iii. the approximately 940 acres of land located in Santa Cruz County Arizona identified as “Lands to DOI” as generally ‘depicted’ on the map entitled “Southeast Arizona Land Exchange and Conservation Act of 2011-Non-Federal Parcel-Appleton Ranch” and dated July 6, 2011.

(2) MANAGEMENT OF ACQUIRED LAND. –

A. LAND ACQUIRED BY THE SECRETARY. –

i. IN GENERAL. – Land acquired by the Secretary under this section shall –

I. become part of the national forest in which the land is located; and

II. be administered in accordance with laws applicable to the National Forest System.

ii. BOUNDARY REVISION. – On the acquisition of land by the Secretary under this section, the boundaries of the national forest shall be modified to reflect the inclusion of the acquired land.

iii. LAND AND WATER CONSERVATION FUND.–For purposes of section 7 of the Land and Water Conservation Fund Act of 1965 (16 U.S.C. 4601-9), the boundaries of a national forest in which land acquired by the Secretary is located shall be deemed to be the boundaries of that forest as in existence on January 1, 1965.

B. LAND ACQUIRED BY THE SECRETARY OF INTERIOR. –

i. SAN PEDRO NATIONAL CONSERVATION AREA. –

I. IN GENERAL. – The land acquired by the Secretary of the Interior under paragraph (1)(B)(i) shall be added to, and administered as part of, the San Pedro National Conservation Area in accordance with the laws (including regulations) applicable to the Conservation Area.

II. MANAGEMENT PLAN. – Not later than 2 years after the date on which the land is acquired, the Secretary of the Interior shall update the management plan for the San Pedro National Conservation Area to reflect the management requirements of the acquired land.

ii. DRIPPING SPRINGS. – Land acquired by the Secretary of the Interior under paragraph (1)(B)(ii) shall be managed in accordance with the Federal Land Policy and Management Act of 1976 (43 U.S.C. 1701 et seq.) and applicable land use plans.

iii. LAS CIENEGAS NATIONAL CONSERVATION AREA. – Land acquired by the Secretary of the Interior under paragraph (1)(B)(iii) shall be added to, and administered as part of, the Las Cienegas National Conservation Area in accordance with the laws (including regulations) applicable to the Conservation Area.

(e) VALUE ADJUSTMENT PAYMENT TO UNITED STATES. –

(1) ANNUAL PRODUCTION REPORTING. –

A. REPORT REQUIRED. – As a condition of the land exchange under this section, Resolution Copper shall submit to the Secretary of the Interior an annual report indicating the quantity of locatable minerals produced during the preceding calendar year in commercial quantities from the Federal land conveyed to Resolution Copper under subsection (c). The first report is required to be submitted not later than February 15 of the first calendar year beginning after the date of commencement of production of valuable locatable minerals in commercial quantities from such Federal land. The reports shall be submitted February 15 of each calendar year thereafter.

B. SHARING REPORTS WITH STATE. – The Secretary shall make each report received under subparagraph (A) available to the State.

C. REPORT CONTENTS. – The reports under subparagraph (A) shall comply with any recordkeeping and reporting requirements prescribed by the Secretary or required by applicable Federal laws in effect at the time of production.

(2) PAYMENT OF PRODUCTION. – If the cumulative production of valuable locatable minerals produced in commercial quantities from the Federal land conveyed to Resolution Copper under subsection (c) exceeds the quantity of production of locatable minerals from the Federal land used in the income capitalization approach analysis prepared under subsection (c)(4)(C), Resolution Copper shall pay to the United States, by not later than March 15 of each applicable calendar year, a value adjustment payment for the quantity of excess production at the same rate assumed for the income capitalization approach analysis prepared under subsection (c)(4)(C).

(3) STATE LAW UNAFFECTED. – Nothing in this subsection modifies, expands, diminishes, amends, or otherwise affects any State law relating to the imposition, application, timing, or collection of a State excise or severance tax.

(4) USE OF FUNDS. –

A. SEPARATE FUNDS. – All funds paid to the United States under this subsection shall be deposited in a special fund established in the 'treasury and shall be available, in such amounts as are provided in advance in appropriation Acts, to the Secretary and the Secretary of the Interior only for the purposes authorized by subparagraph (B).

B. AUTHORIZED USES. – Amounts in the special fund established pursuant to subparagraph (A) shall be used for maintenance, repair, and rehabilitation projects for Forest Service and Bureau of Land Management assets.

(f) WITHDRAWAL. – Subject to valid existing rights, Apache Leap and any land acquired by the United States under this section are withdrawn from all forms of –

(1) entry, appropriation, or disposal under the public land laws;

(2) location, entry, and patent under the mining laws;

(3) disposition under the mineral leasing, mineral materials, and geothermal leasing laws.

(g) APACHE LEAP SPECIAL MANAGEMENT AREA. –

(1) DESIGNATION. – To further the purpose of this section, the Secretary shall establish a special management area consisting of Apache Leap, which shall be known as the “Apache Leap Special Management Area” (referred to in this subsection as the “special management area”).

(2) PURPOSE. – The purposes of the special management area are-

A. to preserve the natural character of Apache Leap;

B. to allow for traditional uses of the area by Native American people; and

C. to protect and conserve the cultural and archeological resources of the area.

(3) SURRENDER OF MINING AND EXTRACTION RIGHTS. – As a condition of the land exchange under subsection (c), Resolution Copper shall surrender to the United States, without compensation, all rights held under the mining laws and any other law to commercially extract minerals under Apache Leap.

(4) MANAGEMENT. –

A. IN GENERAL. – The Secretary shall manage the special management area in a manner that furthers the purposes described in paragraph (2).

B. AUTHORIZED ACTIVITIES. – The activities that are authorized in the special management area are –

i. installation of seismic monitoring equipment on the surface and subsurface to protect the resources located within the special management area;

ii. installation of fences, signs, or other measures necessary to protect the health and safety of the public; and

iii. operation of an underground tunnel and associated workings, as described in the Resolution mine plan of operations, subject to any terms and conditions the Secretary may reasonably require.

(5) PLAN. –

A. IN GENERAL. – Not later than 3 years after the date of enactment of this Act, the Secretary, in consultation with affected Indian tribes, the Town, Resolution Copper, and other interested members of the public, shall prepare a management plan for the Apache Leap Special Management Area.

B. CONSIDERATIONS. – In preparing the plan under subparagraph (A), the Secretary shall consider whether additional measures are necessary to –

i. protect the cultural, archaeological, or historical resources of Apache Leap, including permanent or seasonal closures of all or a portion of Apache Leap; and

ii. provide access for recreation.

(6) MINING ACTIVITIES. – The provisions of this subsection shall not impose additional restrictions on mining activities carried out by Resolution Copper adjacent to, or outside of, the Apache Leap area beyond those otherwise applicable to mining activities on privately owned land under Federal, State, and local laws, rules and regulations.

(h) CONVEYANCES TO TOWN OF SUPERIOR, ARIZONA. –

(1) CONVEYANCES. – On request from the Town and subject to the provisions of this subsection, the Secretary shall convey to the Town the following:

A. Approximately 30 acres of land as depicted on the map entitled “Southeast Arizona Land Exchange and Conservation Act of 2011-Federal Parcel-Fairview Cemetery” and dated March 2011.

B. The reversionary interest and any reserved mineral interest of the United States in the approximately 265 acres of land located in Pinal County, Arizona, as depicted on the map entitled “Southeast Arizona Land Exchange and Conservation Act of 2011-Federal Reversionary Interest-Superior Airport” and dated March 2011.

C. The approximately 250 acres of land located in Pinal County, Arizona, as depicted on the map entitled “Southeast Arizona Land Exchange and Conservation Act of 2011-Federal Parcel-Superior Airport Contiguous Parcels” and dated March 2011.

(2) PAYMENT. – The Town shall pay to the Secretary the market value for each parcel of land or interest in land acquired under this subsection, as determined by appraisals conducted in accordance with subsection (c)(4).

(3) SISK ACT. – Any payment received by the Secretary from the Town under this subsection shall be deposited in the fund established under Public Law 90-171 (commonly known as the “Sisk Act”) (16 U.S.C. 484a) and shall be made available to the Secretary for the acquisition of land or interests in land in Region 3 of the Forest Service.

(4) TERMS AND CONDITIONS. – The conveyances under this subsection shall be subject to such terms and conditions as the Secretary may require.

(i) MISCELLANEOUS PROVISIONS. –

(1) REVOCATION OF ORDERS; WITHDRAWAL. –

A. REVOCATION OF ORDERS. – Any public land order that withdraws the Federal land from appropriation or disposal under a public land law shall be revoked to the extent necessary to permit disposal of the land.

B. WITHDRAWAL. – On the date of enactment of this Act, if the Federal land or any Federal interest in the non-Federal land to be exchanged under subsection (c) is not withdrawn or segregated from entry and appropriation under a public land law (including mining and mineral leasing laws and the Geothermal Steam Act of 1970 (30 U.S.C. 1001 et seq.)), the land or interest shall be withdrawn, without further action required by the Secretary concerned, from entry and appropriation.
The withdrawal shall be terminated-

   i. on the date of consummation of the land exchange; or

   ii. if Resolution Copper notifies the Secretary in writing that it has elected to withdraw from the land exchange pursuant to section 206(d) of the Federal Land Policy and Management Act of 1976, as amended (43 U.S.C. 1716(d)).

C. RIGHTS OF RESOLUTION COPPER. – Nothing in this section shall interfere with, limit, or otherwise impair, the unpatented mining claims or rights currently held by Resolution Copper on the Federal land, nor in any way change, diminish, qualify, or otherwise impact Resolution Copper's right- and ability to conduct activities on the Federal land under such unpatented mining claims and the general mining laws of the United States, including the permitting or authorization of such activities.

(2) MAPS, ESTIMATES, AND DESCRIPTIONS. –

A. MINOR ERRORS. – The Secretary concerned and Resolution Copper may correct, by mutual agreement, any minor errors in any map, acreage estimate, or description of any land conveyed or exchanged under this section.

B. CONFLICT. – If there is a conflict between a map, an acreage estimate, or a description of land in this section, the map shall control unless the Secretary concerned and Resolution Copper mutually agree otherwise.

C. AVAILABILITY. – On the date of enactment of this Act, the Secretary shall file and make available for public inspection in the Office of the Supervisor, Tonto National Forest, each map referred to in this section.

(3) PUBLIC ACCESS IN AND AROUND OAK FLAT CAMPGROUND. – As a condition of conveyance of the Federal land, Resolution Copper shall agree to provide access to the surface of the Oak Flat Campground to members of the public, including Indian tribes, to the maximum extent practicable, consistent with health and safety requirements, until such time as the operation of the mine precludes continued public access for safety reasons, as determined by Resolution Copper.

APPENDIX B. EXISTING CONDITIONS OF OFFERED LANDS

Existing Conditions of Offered Lands

Overview of Land Exchange

Section 3003 of the Carl Levin and Howard P. 'Buck' McKeon National Defense Authorization Act for Fiscal Year 2015 (NDAA) directs the conveyance of approximately 2,422 acres of specified National Forest System (NFS) lands to Resolution Copper Mining, LLC (Resolution Copper) if Resolution Copper offers to convey approximately 5,374 acres of private lands to the United States, which Resolution Copper has done. Table B-1 provides a brief summary of the land exchange parcels. A detailed description of the land exchange can be found in section 2.2.1.1 of the draft environmental impact statement (DEIS). The complete Section 3003 of the NDAA is provided in appendix A of the DEIS.

Table B-1. Summary of land exchange parcels

Parcel Landownership	Description of Parcels to Be Exchanged
Parcels transferred from the United States to Resolution Copper	• 2,422 acres near Superior in Pinal County, Arizona, known as the **Oak Flat Federal Parcel**, to become private lands
Parcels transferred from Resolution Copper to the United States, to be included in the NFS	• 140 acres* near Superior in Pinal County, Arizona, known as the **Apache Leap South End Parcel**, to be administered by the Tonto National Forest • 148 acres in Yavapai County, Arizona, known as the **Tangle Creek Parcel**, to be administered by the Tonto National Forest • 147 acres in Gila County, Arizona, known as the **Turkey Creek Parcel**, to be administered by the Tonto National Forest • 149 acres near Cave Creek in Maricopa County, Arizona, known as the **Cave Creek Parcel**, to be administered by the Tonto National Forest • 640 acres north of Payson in Coconino County, Arizona, known as the **East Clear Creek Parcel**, to be administered by the Coconino National Forest
Parcels transferred from Resolution Copper to the U.S. Department of the Interior	• 3,050 acres near Mammoth in Pinal County, Arizona, known as the **Lower San Pedro River Parcel**, to be administered by the U.S. Department of the Interior Bureau of Land Management (BLM) as part of the San Pedro Riparian National Conservation Area • 940 acres south of Elgin in Santa Cruz County, Arizona, known as the **Appleton Ranch Parcel**, to be administered by the BLM as part of the Las Cienegas National Conservation Area • 160 acres near Kearny in Gila and Pinal Counties, Arizona, known as the **Dripping Springs Parcel**, to be administered by the BLM
If requested by the Town of Superior, Arizona, land would be transferred from the United States to the Town of Superior	• 30 acres associated with the Fairview Cemetery • 250 acres associated with parcels contiguous to the Superior Airport • 265 acres of Federal reversionary interest associated with the Superior Airport

* Using updated survey information provided by Resolution Copper, the U.S. Forest Service revised the Apache Leap South End Parcel from 110 acres (as presented in the NDAA) to 140 acres. Acreage of all other parcels is subject to revision upon completion of all survey work by the BLM.

Offered Lands – Forest Service

The offered lands include 5,374 acres of Resolution Copper private land on eight parcels located throughout Arizona. The parcels of offered lands would be transferred to the United States, for administration by either the U.S. Department of Agriculture Forest Service (Forest Service) or the U.S. Department of the Interior Bureau of Land Management (BLM).

Details of the private parcels that would be transferred to the United States with management by the Forest Service are in the following text. Additional details regarding the special status species present on

the offered lands being transferred to the Tonto National Forest, Coconino National Forest, and BLM are summarized in tables B-2, B-3, and B-4, respectively, at the end of this appendix.

APACHE LEAP SOUTH END PARCELS

As noted later in this section, the Apache Leap South End Parcels would become part of the Apache Leap Special Management Area (SMA), administered by the Tonto National Forest, Globe Ranger District. The NDAA required completion of a management plan for the Apache Leap SMA. Preparation of the management plan was conducted through a separate National Environmental Policy Act (NEPA) process, which resulted in an environmental assessment (August 2017) and the final management plan (December 2017). Substantial information about the Apache Leap South End Parcels can be found in that environmental assessment (see "Key Documents Describing Apache Leap South End Parcels" later in this section). The Apache Leap management plan would exclude future grazing leases and limit construction and motorized vehicles to protect the natural character of the area.

Parcel Description

The Apache Leap South End Parcels consist of three parcels that total 140 acres, located near the eastern edge of the town of Superior in Pinal County, Arizona (figures B-1 and B-2). The Apache Leap South End Parcels are surrounded by NFS lands and would become part of the Apache Leap SMA, administered by the Tonto National Forest, Globe Ranger District. Upon completion of the land exchange, Resolution Copper would surrender all mining claims and interests to the parcels. Portions of the parcels are accessible by unimproved roads and trails from below Apache Leap via Ray Road/Apache Leap Road from Arizona State Route 177, or from above Apache Leap via NFS Road 315 via Magma Mine Road.

Figure B-1. Photograph of Apache Leap South parcels

The parcels include lands located above and below Apache Leap, an escarpment of sheer cliff faces, hoodoos, and buttresses that forms the scenic backdrop to the town of Superior. Current land uses on the parcels include livestock grazing and informal recreation such as hiking, rock climbing, nature viewing, and hunting. Additionally, there are multiple historical mining features and remnants of old mining-related roads located throughout the parcels, including small open cuts, shafts, tunnels, raises, crosscuts, and more extensive underground workings. The major underground mines in this area were principally known as the Grand Pacific and Belmont mines. Entrances to these mines are found on portions of the parcels and appear to date to the early 1900s, with evidence of having been explored historically for the presence of economic minerals. In a few instances, this exploration led to mineral development and exploitation.

Geological Setting

This area lies in a transitional zone on the northeastern edge of the Basin and Range physiographic province. The western edge of this area is generally very steep, with the cliffs of the Apache Leap escarpment rising abruptly above the town of Superior. There is roughly up to 1,970 feet of vertical displacement along the escarpment and Superior is in a down-dropped fault basin. The Tertiary-aged Apache Leap Tuff, the youngest consolidated formation in the area, forms the Apache Leap escarpment, and the underlying Paleozoic sedimentary rocks and Precambrian sedimentary rocks are exposed at the foot of the escarpment. Tertiary-aged Whitetail Conglomerate is present, with limited exposure at the toe of the slope on the western side of Apache Leap. A Quaternary alluvial deposit overlies the Apache Leap Tuff in a small area in the southwestern portion of the parcels.

Biological and Water Resources

Major biotic communities within the Apache Leap South Parcels include the Arizona Upland subdivision – Sonoran Desertscrub vegetation community in lower elevations and Interior Chaparral along the top of the Apache Leap escarpment (Brown 1994). Interior Chaparral species also occur on north-facing slopes in lower elevations west of the Apache Leap escarpment.

Vegetation found in the Arizona Upland subdivision typically consists of shrubs, cacti, and leguminous trees such as foothill paloverde, saguaro, and velvet mesquite. Additional species common to this area include goldenflower century plant, Mormon tea, fairyduster, barrel cactus, catclaw mimosa, jojoba, catclaw acacia, wolfberry, brittlebush, teddybear cholla, buckhorn cholla, cactus apple, Engelmann's hedgehog, shrubby buckwheat, flattop buckwheat, Louisiana sagewort, desert marigold, Coues' cassia, desert globemallow, and purple three-awn.

The Interior Chaparral vegetation type is characterized by dense stands of woody evergreens and shrubs. A common (diagnostic) species of Interior Chaparral in central Arizona is scrub live oak. In the Apache Leap SMA, this community is best represented by scrub live oak, pointleaf manzanita, red barberry, alderleaf mountain mahogany, deerbrush, and sugar sumac. Other common species include crucifixion thorn, hopbush, Wright's silktassel, and broom snakeweed.

Three special status plant species have the potential to occur within the parcels: Arizona hedgehog cactus, Pima Indian mallow, and mapleleaf false snapdragon. All may occur but are not known to occur. There is suitable habitat for Arizona hedgehog cactus in the northern portion of the parcels, and the parcels are near known populations of the species. However, the species' presence was not confirmed during site visits or during informal surveys specifically searching for the species by Forest Service biologists over the past several years.

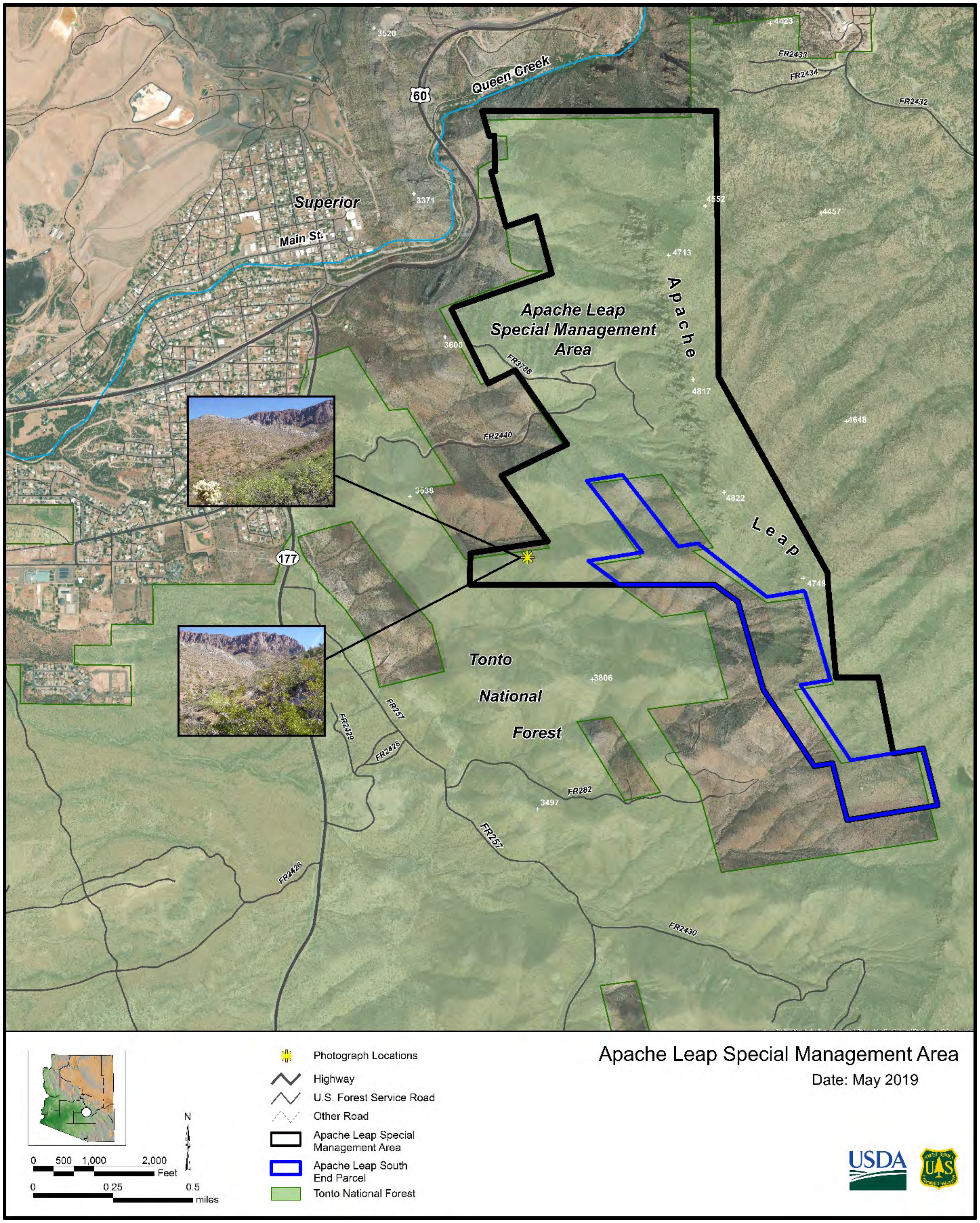

Figure B-2. Apache Leap Special Management Area and land exchange parcel

Drainages within the project area do not contain permanent surface water features and do not support riparian vegetation. Instead, the drainages generally contain greater densities of the same species that are present in the adjacent uplands. Additionally, no known springs occur within the Apache Leap South End Parcels.

Hazardous Materials

A Phase 1 environmental site assessment was completed for the property in August 2015, and identified no recognized environmental conditions (RECs) on the property. Historic-era mine features were noted during the work, but while there is potential for the historic mine features to impact groundwater or produce acid mine drainage, no discoloration or distressed vegetation was noted around the existing features. In addition, potential for impacts on surface or groundwater by contact with mineralized rock is not considered likely. Most adits are closed for human safety while allowing continued bat use.

Cultural Resources

The parcels are generally characterized as undeveloped open space with no evidence of human occupation. A Class III cultural resources inventory was performed in 2016 and found three archaeological sites, two of which were new discoveries. Of these, one site was considered eligible for the National Register of Historic Places (NRHP). Additionally, numerous cultural resources inventories have identified sites representing Prehistoric, Protohistoric, and Historic Native American occupations and activities spanning several thousand years in the areas surrounding the parcels. Historic Euro-American activities have also been identified, including ranching, transportation, and utilities in combination with mining operations; these date to the late nineteenth century through the middle twentieth century.

Key Documents Describing Apache Leap South End Parcels

- SWCA Environmental Consultants. 2017. “Apache Leap Special Management Area Management Plan: Heritage Resources Report.” August 1, 2017 (Tremblay 2017)
- SWCA Environmental Consultants. 2017. “Apache Leap Special Management Area Wildlife and Vegetation Specialist Report.” August 1, 2017 (Dugan 2017)
- SWCA Environmental Consultants. 2017. “Apache Leap Special Management Area Biological Evaluation.” August 1, 2017 (Campbell and Dugan 2017)
- U.S. Forest Service. 2014. Tonto National Forest’s Nomination of *Chi'chil Biłdagoteel*, commonly known as Oak Flat and Apache Leap, to the National Register of Historic Places as an Apache Traditional Cultural Property. October 31, 2014 (Nez 2014)
- U.S. Forest Service. 2017. “Apache Leap Special Management Area Management Plan: Environmental Assessment and Finding of No Significant Impact.” August 1, 2017 (U.S. Forest Service 2017a)
- U.S. Forest Service. 2017. “Apache Leap Special Management Area: Management Plan.” December 1, 2017 (U.S. Forest Service 2017c)
- U.S. Forest Service. 2017. “Apache Leap Special Management Area Management Plan: Errata to Final Environmental Assessment.” December 1, 2017 (U.S. Forest Service 2017b)
- WestLand Resources Inc. 2015. “Phase I Environmental Site Assessment Apache Leap South End [Phase I Environmental Assessment Non-Federal Parcel Apache Leap South End Gila County, Arizona].” August 13, 2015 (WestLand Resources Inc. 2015b)

- WestLand Resources Inc. 2016. "A Cultural Resources Inventory of 106 Acres Along the South End of Apache Leap for Resolution Copper Mining, LLC, Pinal County, Arizona." June 23, 2016 (Daughtrey 2016)

TANGLE CREEK PARCEL

Parcel Description

Located in Yavapai County, Arizona, approximately 35 miles north of the towns of Cave Creek and Carefree, the Tangle Creek Parcel is a 148-acre private inholding within the Tonto National Forest (figures B-3 and B-4). The parcel would be administered by the Tonto National Forest, Cave Creek Ranger District. The Tangle Creek parcel lies within the Central Highlands physiographic province, a transition zone between the Basin and Range and the Colorado River provinces.

Figure B-3. Photograph of Tangle Creek parcel

The Tangle Creek Parcel is located near the center of a broad valley known as Bloody Basin, a rugged and scenic basin in central Arizona with abundant hiking, camping, and hunting opportunities. The parcel lies adjacent to Seven Springs Recreation Area, Cave Creek Campground and Trailhead, and Civilian Conservation Corps Campground, with known recreational uses that include fishing, boating, swimming, nature viewing, outdoor learning, and picnicking; however, no boating, fishing, or swimming occur on the Tangle Creek Parcel. The parcel was homesteaded in the 1890s by the Babbitt family and used for livestock grazing and farming through the 1990s. Developed features within the parcel are limited; the only remaining associated improvements include an overgrown dirt road, remnants of a concrete dam/revetment structure, water pipelines, a small concrete foundation, water troughs, and wells. The historically cultivated farm fields are in the process of reverting to open woodlands and thickets of hackberry, mesquite, and catclaw acacia. Resolution Copper does not use the parcel for any specific purpose. Several unimproved roads provide public access to the area and are likely used for recreational, grazing, and agricultural purposes. The parcel is within a grazing allotment that includes surrounding lands in all directions. The parcel also contains a power line transmission corridor. No active mining claims exist within the parcel.

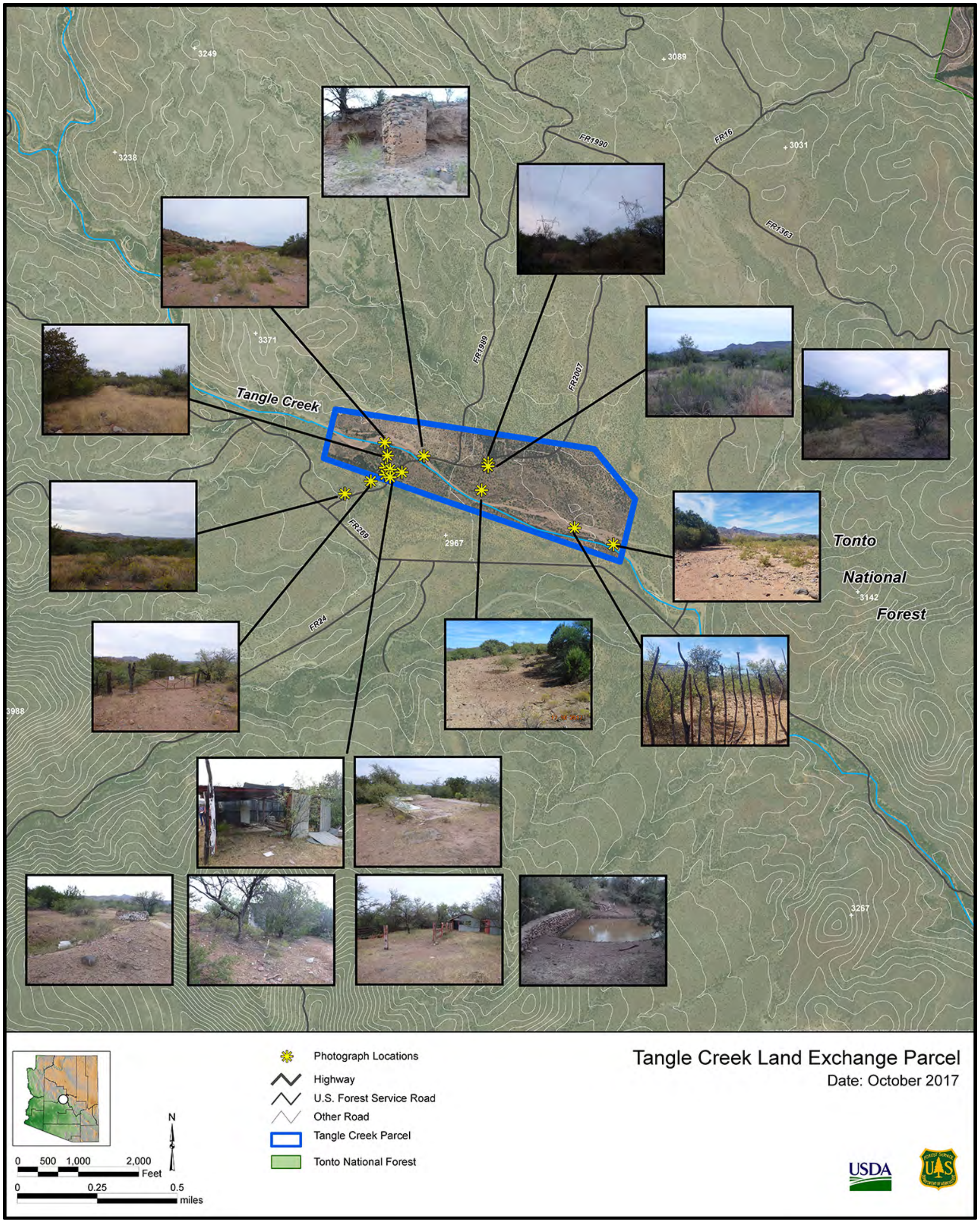

Figure B-4. Tangle Creek land exchange parcel

The parcel can be accessed from the west via Bloody Basin Road (NFS Road 269) from Interstate 17 or by traveling north from Carefree along Cave Creek Road (NFS Road 24).

Geological Setting

This parcel is located along Tangle Creek in Bloody Basin, which is in the Central Highlands physiographic province, a transitional zone between the Basin and Range and the Colorado Plateau. The Bloody Basin area is a graben, bounded to the west by Cooks Mesa and to the east by the Mazatzal Mountains. It is mapped as Tertiary-aged deposits.

Biological and Water Resources

Upland vegetation of the parcel is mapped as Great Basin Conifer Woodland; however, vegetation characteristic of the Arizona Upland Subdivision of the Sonoran Desertscrub, the Semi-Desert Grassland, and Sonoran Deciduous Riparian Forest biotic communities were also observed during field reconnaissance. Common plant species include one-seed juniper, oats grama, saguaro, sycamores, ash, and desert willow.

Features of the Tangle Creek Parcel include Tangle Creek, a spatially intermittent to perennial stream that bisects the parcel and acts as a substantial tributary to the Verde River (located approximately 10 miles downstream) and associated riparian habitat, as well as mature netleaf hackberry, mesquite, ash, and sycamore trees, which provide habitat for migratory birds and nesting songbirds. No aquatic biology surveys have been conducted. One spring, LX Spring, exists outside the parcel and water from this spring was conveyed to the parcel by pipeline. The water right for LX Spring water use at the Tangle Creek parcel is no longer active.

No critical habitats exist within the parcel. The 2004 ecological overview identified three special status species (under the Endangered Species Act [ESA]) with some potential to occur within the property: Arizona agave (endangered), Arizona cliffrose (endangered), and bald eagle (now delisted, but still protected under the Bald and Golden Eagle Protection Act [BGEPA]). More recent screening identified a number of other special status species with some potential to occur within the property (either under the ESA, BGEPA, or identified as a Tonto National Forest sensitive species):

- ESA: western yellow-billed cuckoo (threatened); southwestern willow fly-catcher (endangered); Gila chub (endangered); spikedace (endangered)
- BGEPA: golden eagle
- Tonto National Forest sensitive species: lowland leopard frog; peregrine falcon; desert sucker; headwater chub; roundtail chub; pale Townsend’s big-eared bat; spotted bat; Allen’s lappet-browed or big-eared bat; western red bat; Sonoran desert tortoise; Parker’s cylloepus riffle beetle

Hazardous Materials

A Phase 1 environmental site assessment was completed for the property in October 2016, and identified no RECs on the property. A prior Phase 1 environmental site assessment in 2004 had identified numerous potential environmental conditions associated with a building, but it was subsequently determined that the building was not on the parcel itself. In 2016, the only item noted was a drum that did not appear to contain more than traces of fluid and was not observed to be leaking. Resolution Copper undertook a substantial cleanup of the Tangle Creek parcel in 2018 to remove trash and other materials.

Cultural Resources

A Class III cultural resources inventory was performed in 2016, recording 10 previously undiscovered archaeological sites, of which seven were recommended eligible for inclusion in the NRHP. In addition, 22 archaeological sites had been previously discovered within the vicinity of the parcel, many of which are indicative of substantial Formative period occupation.

Key Documents Describing Tangle Creek Parcel

- WestLand Resources Inc. 2004. “Ecological Overview LX Bar Ranch Parcel, Yavapai County Arizona.” March 8, 2004 (WestLand Resources Inc. 2004d)
- WestLand Resources Inc. 2016. “A Cultural Resources Inventory of the 148-Acre Tangle Creek Parcel, Yavapai County, Arizona: Resolution Copper.” September 28, 2016 (Charest 2016b)
- WestLand Resources Inc. 2016. “Phase I Environmental Assessment Non-Federal Parcel, Tangle Creek (LX Bar Ranch) Yavapai County, Arizona, Resolution Copper.” October 1, 2016 (WestLand Resources Inc. 2016c)

TURKEY CREEK PARCEL

Parcel Description

The Turkey Creek Parcel is a 147-acre parcel located approximately 8 miles southeast of the community of Pleasant Valley in Gila County, Arizona (figures B-5 and B-6). Also known as JX Ranch, the Turkey Creek Parcel is a private inholding within the Tonto National Forest and would be administered by the Tonto National Forest, Pleasant Valley Ranger District. It is located within the streambed and adjacent upland areas along Turkey Creek and Rock Creek in the Sierra Ancha Mountains within the Central Highlands physiographic province, a transitional zone between the Basin and Range and the Colorado Plateau provinces.

The parcel was formerly homesteaded in the 1880s and associated with Elmer D. Boody. Development includes a series of buildings and property improvements such as a house, barn, kitchen, storehouse, tool house, shop, well, and cultivated area. The parcel also includes remains of a trail, a small apple orchard, and a scattering of historical artifacts. A dry-laid masonry well that appears to have been filled in almost entirely by sediment or possibly trash was observed on the former homestead location. The Boody homestead would eventually become known as JX Ranch. Under Resolution Copper ownership, the parcel is not used for any purpose; however, there is evidence of dispersed recreation including hunting, nature viewing, hiking, picnicking, camping, and off-highway vehicle use. Overall, the parcel is characterized as mainly vacant open space that appears to have been used in the past for historical homesteading and grazing. Currently there are no active mining claims within the parcel.

The parcel can be accessed by going east and north approximately 22 miles from State Route 188 along multiple NFS Roads (71, 609, 416, and 2768).

Figure B-5. Photograph of Turkey Creek parcel

Geological Setting

This parcel is located in the Sierra Ancha Mountains, which are in the Central Highlands physiographic province, a transitional zone between the Basin and Range and the Colorado Plateau. The parcel has middle Tertiary-aged conglomerate on the canyon's upper slopes, Precambrian-aged (middle Proterozoic) Dripping Springs Quartzite exposed in cliff faces adjacent to the stream bed, and Quaternary alluvium within the valley floor along Turkey Creek and Rock Creek.

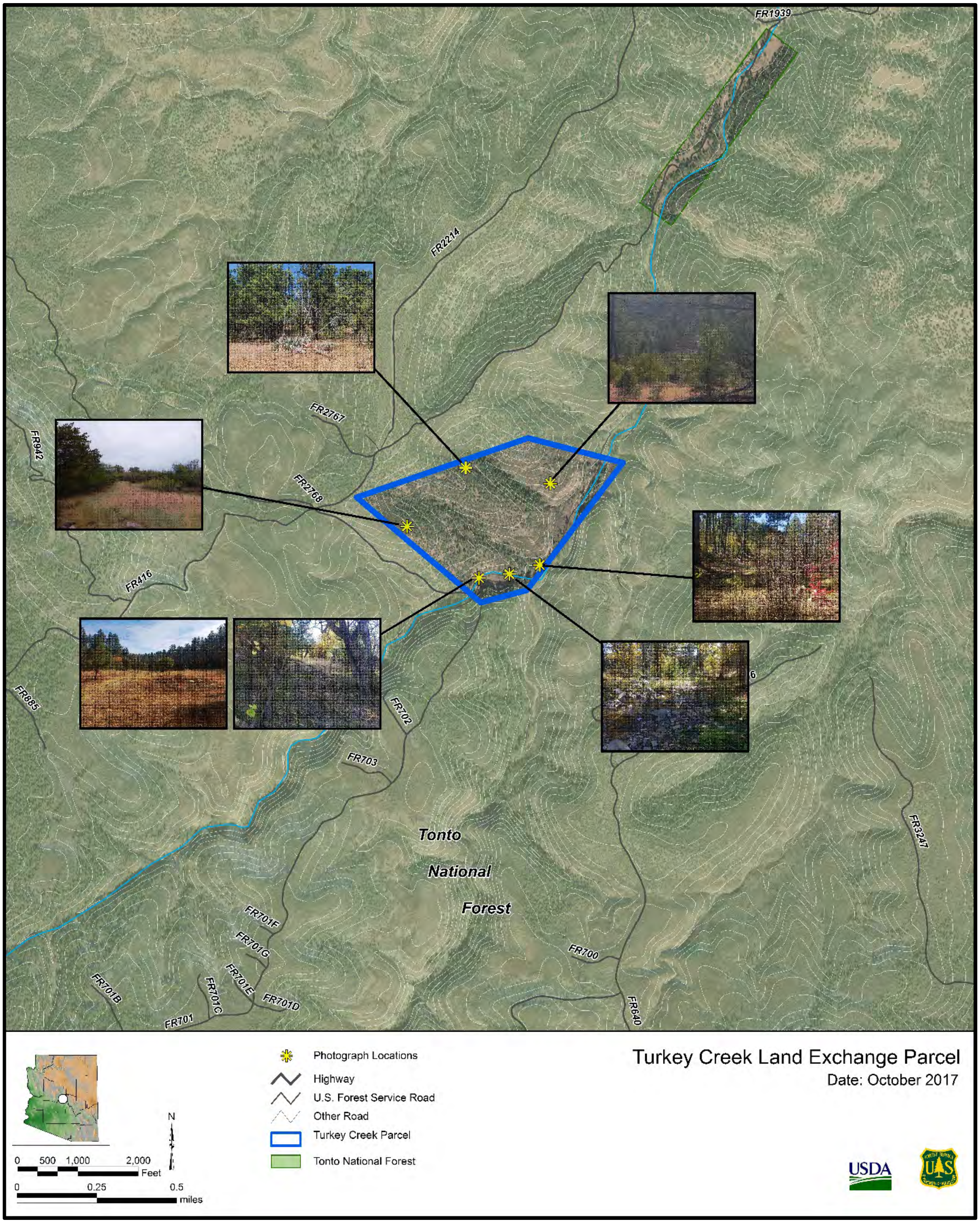

Figure B-6. Turkey Creek land exchange parcel

Biological and Water Resources

Four biotic communities were observed during field reconnaissance: Petran Montane Conifer Forest, Madrean Evergreen Woodland, Interior Chaparral, and Great Basin Conifer Woodland; however, the upland vegetation on the parcel is only mapped as Great Basin Conifer Woodland biotic community. Common plants include ponderosa pine on north-facing slopes and alligator juniper, manzanita, and grasses on south-facing slopes. Riparian vegetation such as narrowleaf cottonwood, New Mexico locust, Arizona sycamore, and Gambel oak are present along Turkey Creek. Approximately one-third of the vegetation within the parcel was impacted by fires in the early 2000s, with some areas burning intensely, resulting in losses of entire stands of juniper, ponderosa pine, and manzanita. Natural vegetation is reestablishing, however. Within the parcel there is habitat for elk, mule deer, and native fish.

Additionally, the parcel is within Forest Service lands that contain Mexican spotted owl critical habitat, as well as two Mexican spotted owl protected activity centers. The 2004 ecological overview identified three special status species with some potential to occur within the property: Arizona agave (endangered), Chiricahua leopard frog (threatened), and bald eagle (now delisted, but still protected under the BGEPA). More recent screening identified a number of other special status species with some potential to occur within the property (either under the ESA, BGEPA, or identified as a Tonto National Forest sensitive species):

- ESA: western yellow-billed cuckoo (threatened); southwestern willow fly-catcher (endangered); Chiricahua leopard frog (threatened); Mexican spotted owl (threatened); Gila chub (endangered); spikedace (endangered); northern Mexican gartersnake (threatened); narrow-headed gartersnake (threatened)
- BGEPA: golden eagle
- Tonto National Forest sensitive species: lowland leopard frog; peregrine falcon; northern goshawk; Sonora sucker; desert sucker; headwater chub; roundtail chub; pale Townsend’s big-eared bat; spotted bat; Allen’s lappet-browed or big-eared bat; western red bat

Turkey Creek is the dominant drainage feature in the parcel and has intermittent to perennial flow. Surface water features comprise ephemeral channels that are tributary to Turkey Creek in the Salt River’s watershed.

Wildfires in the area in 2018 may have affected the property and surrounding lands.

Hazardous Materials

A Phase 1 environmental site assessment was completed for the property in October 2016, and identified no RECs on the property.

Cultural Resources

A Class III cultural resources inventory of the parcel was performed in 2016 and found six previously undiscovered archaeological sites, with five of the sites recommended eligible for inclusion in the NRHP. Sites were dated to the Late Formative period (over a range of 1,000 years) and the Late Historic period.

Key Documents Describing Turkey Creek Parcel

- WestLand Resources Inc. 2004. “Ecological Overview JX Ranch Parcel, Gila County, Arizona.” March 31, 2004 (WestLand Resources Inc. 2004c)

- WestLand Resources Inc. 2016. “A Cultural Resources Inventory of the 146.78-Acre Turkey Creek Parcel, Gila County, Arizona: Resolution Copper.” September 28, 2016 (Charest 2016b)
- WestLand Resources Inc. 2016. “Phase I Environmental Site Assessment Non-Federal Parcel, Turkey Creek (JX Bar Ranch) Gila County, Arizona.” October 1, 2016 (WestLand Resources Inc. 2016f)

CAVE CREEK PARCEL

Parcel Description

The Cave Creek Parcel is a 149-acre parcel located approximately 7 miles north of Cave Creek in Maricopa County, Arizona, known also as 6L Ranch (figures B-7 and B-8). The Cave Creek Parcel is a private inholding surrounded by Tonto National Forest lands. Upon completion of the land exchange, the parcel would be administered by the Tonto National Forest, Cave Creek Ranger District. The parcel lies along the canyon floor and adjacent upland areas of Cave Creek in the Central Highlands physiographic province.

Figure B-7. Photograph of Cave Creek parcel

The Cave Creek parcel is located north of the Spur Cross Ranch Conservation Area, used for dispersed recreation activities such as hunting, camping, nature viewing, and hiking. The parcel was initially settled in the 1880s and used as a residence until the 1920s. Livestock grazing occurred on the parcel through 2001. Several ranching features were observed through field reconnaissance and include development such as a concrete watering trough, pipes, a steel cistern, a well, a collapsed dry-laid masonry outbuilding with tin roof, a wooden cattle chute, and a corral area. The parcel is largely devoid of development, and there is no evidence of recent human occupation within the parcel. The Cave Creek parcel can be accessed via Cave Creek Road and Spur Cross road to Forest Trail 4, on which a 40-minute walk on foot

is required to reach the parcel. Drivable access is limited at the Maricopa County Spur Cross Ranch Conservation Fence. No active mining claims exist within the parcel.

Geological Setting

This parcel is located along Cave Creek, which drains the southern portion of the New River Mountains, a rugged range defining the eastern portion of the Agua Fria River valley. Notable peaks around this parcel are Skull Mesa to the east, Sugarloaf Mountain to the southwest, and Black Mesa to the west and north. The parcel lies in the Central Highlands physiographic province. The New River Mountains comprise Quaternary- and Tertiary-aged basalt-covered tablelands cut by streams through Precambrian-aged metavolcanic rocks. Most of the parcel is mapped as volcanic and sedimentary rock dated from the middle Miocene to Oligocene. Small portions of the northern and southern ends of the parcel are mapped as Early Proterozoic Metavolcanic rocks.

Biological and Water Resources

Three biotic communities have been observed within the parcel: Interior Chaparral, Arizona Upland Subdivision of Sonoran Desertscrub, and Deciduous Riparian Forest along Cave Creek. Common plant species include saguaro, foothill paloverde, ironwood, barberry, buckbrush, Arizona sycamore, velvet ash, and Goodding’s willow. Wildlife habitat for migratory songbirds, raptors, amphibians, javelina, mule deer, and coyotes has been identified within the parcel. No aquatic species surveys have been conducted within the parcel.

The 2004 ecological overview identified three special status species with some potential to occur within the property: bald eagle (now delisted, but still protected under the BGEPA), Gila topminnow (endangered), and cactus ferruginous pygmy owl (now delisted).

More recent screening identified a number of other special status species with some potential to occur within the property (either under the ESA, BGEPA, or identified as a Tonto National Forest sensitive species):

- ESA: western yellow-billed cuckoo (threatened); southwestern willow fly-catcher (endangered); lesser long-nosed bat (since delisted)
- BGEPA: golden eagle
- Tonto National Forest sensitive species: lowland leopard frog; peregrine falcon; pale Townsend’s big-eared bat; spotted bat; Allen’s lappet-browed or big-eared bat; western red bat; Sonoran desert tortoise; Parker’s cylloepus riffle beetle

Surface water features include Cave Creek, which originally flowed south toward the Salt River in Phoenix; however, the flow is now intercepted by the Cave Creek Dam in the northern Phoenix metropolitan area and the canal system in Phoenix, which diverts the stream to discharge to the Agua Fria River. The Cave Creek riparian corridor runs through the center of the parcel and drains the southern portion of the New River Mountains. It is ephemeral to intermittent with some perennial reaches in the vicinity of the parcel.

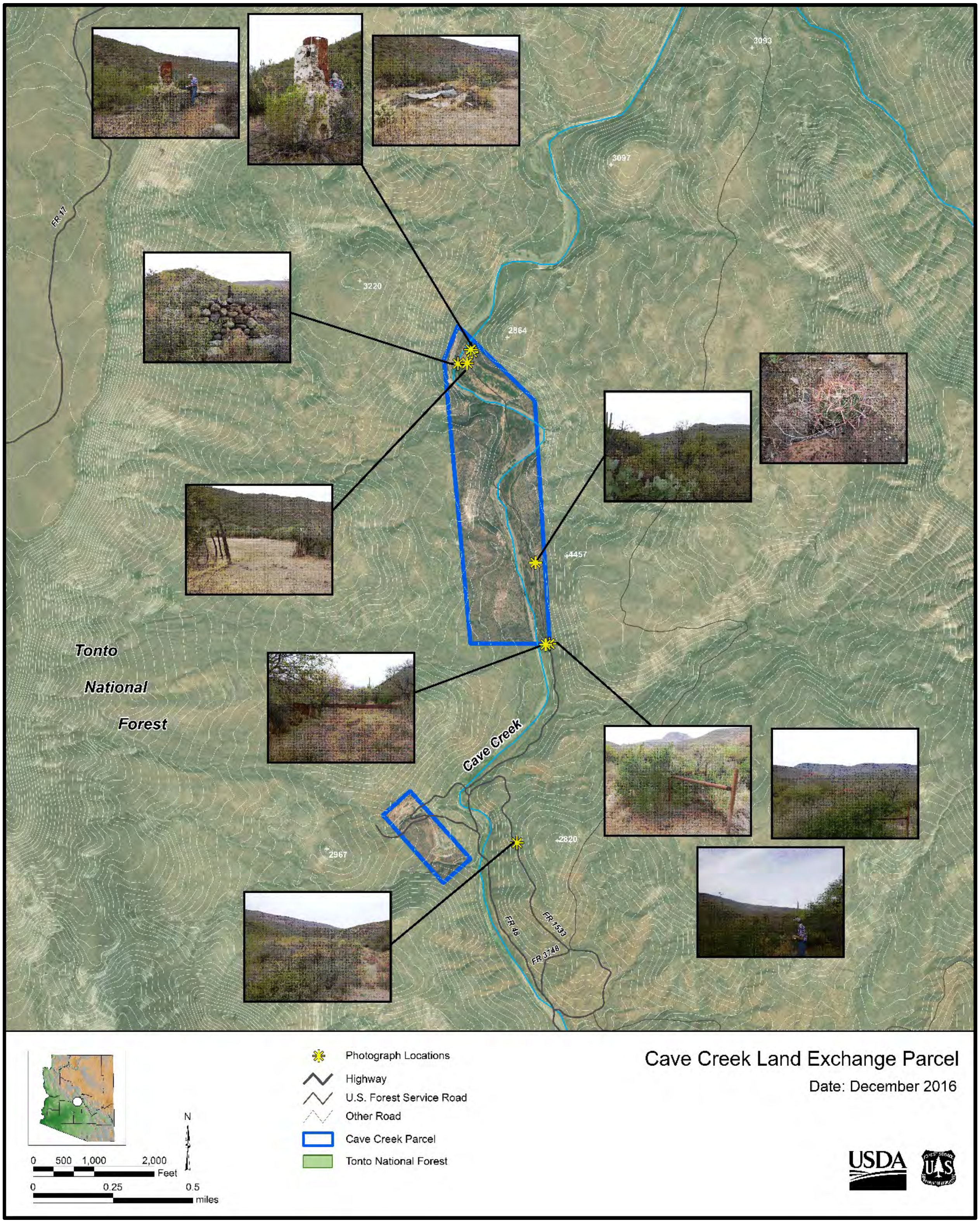

Figure B-8. Cave Creek land exchange parcel

Hazardous Materials

A Phase 1 environmental site assessment was completed for the property in September 2016, and identified no RECs on the property.

Cultural Resources

Prehistorically, the parcel and area were extensively used and occupied by indigenous cultures. A Class III cultural resource inventory was performed in 2016, and identified six archaeological sites including four that were previously undiscovered. All six sites were recommended for inclusion in the NRHP. The sites date to the Late Archaic and Early to Middle, Middle, and Late Formative periods, as well as the Late Historic period, and include prehistoric petroglyphs. Additionally, stone structures, grinding areas, and more petroglyphs have been found in areas surrounding the parcel.

Key Documents Describing Cave Creek Parcel

- WestLand Resources Inc. 2004. “Ecological Overview: 6L Ranch Parcel, Yavapai County, Arizona.” July 19, 2004 (WestLand Resources Inc. 2004a)
- WestLand Resources Inc. 2016. “Phase I Environmental Site Assessment Non-Federal Parcel, Cave Creek (6L Ranch) Maricopa County, Arizona, Resolution Copper.” September 1, 2016 (WestLand Resources Inc. 2016e)
- WestLand Resources Inc. 2016. “A Cultural Resources Inventory of the 149.18-Acre Cave Creek Parcel, Maricopa County, Arizona: Resolution Copper.” September 28, 2016 (Charest and Francis 2016)

EAST CLEAR CREEK PARCEL

Parcel Description

The East Clear Creek Parcel is a 640-acre private inholding within the Coconino National Forest, located north of Payson in Coconino County, Arizona (figures B-9 and B-10). The parcel would be administered by the Mogollon Rim Ranger District. The East Clear Creek Parcel is located along the canyon floor and adjacent upland areas of East Clear Creek in the Colorado Plateau physiographic province, a transitional zone between the upper plateau and riparian ecosystems on the Mogollon Rim.

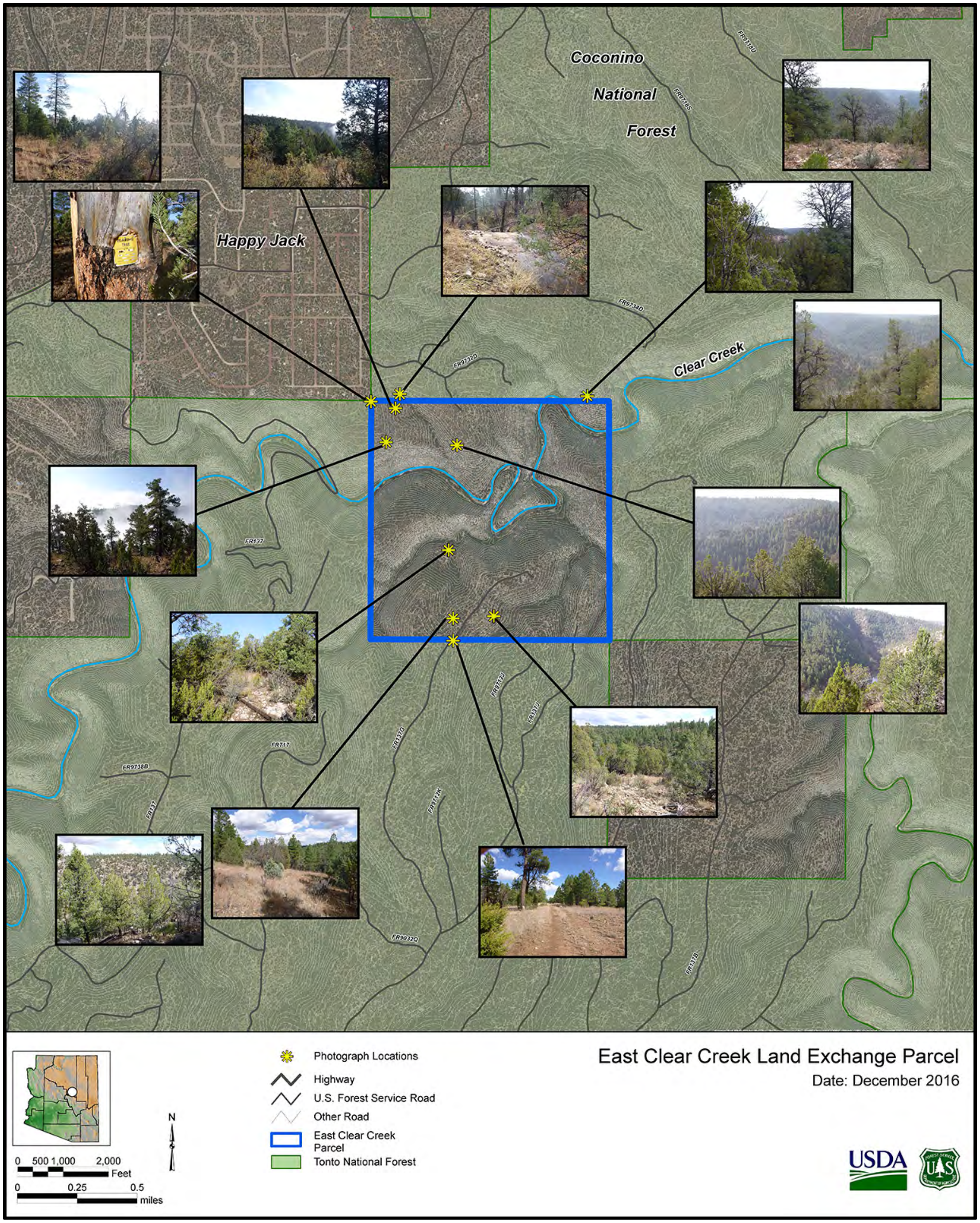

Figure B-9. East Clear Creek land exchange parcel

The only known current and historical uses of the area are recreation and logging. Designated pack trails are present on Forest Service land south and east of the parcel. Hiking, fishing, nature viewing, hunting, and camping are available on the public lands surrounding the parcel. The parcel is surrounded by the T Bar grazing allotment; however, Resolution Copper does not manage this grazing lease. BLM records show a Record of Patent for the parcel to the Santa Fe Pacific Railroad Company for the purpose of constructing a railroad and telegraph line from Missouri and Arkansas to the Pacific Coast; however, there is no evidence within the parcel or adjoining areas that the railroad was ever developed. Logging has historically been conducted in the vicinity of the parcel, with the most recent timber sale occurring in the late 1980s. There is a stock tank near the southern boundary of the parcel, suggesting livestock grazing as a potential historical land use, although not within at least the last 10 years. There is no recent development on the parcel. Dirt roads are the only developed, formal use. No active mining claims exist within the parcel.

Figure B-10. Photograph of East Clear Creek parcel

The parcel can be accessed from the south via State Route 87 and traveling approximately 12 miles to the east and north. There is no designated access into the property from the north, but it is adjacent to the Starlight Pines subdivision.

Geological Setting

This parcel is located in the canyon floor and adjacent uplands along East Clear Creek. The East Clear Creek parcel is in the Colorado Plateau physiographic province, which is bounded on the south by the Mogollon Rim and is characterized by nearly horizontal, stratified sedimentary rocks that have been eroded into numerous canyons, plateaus, and scarps. The canyon walls are steep adjacent to East Clear Creek and upland areas are rugged. The entire parcel is mapped as Permian-aged sedimentary rocks.

Biological and Water Resources

The upland vegetation on the East Clear Creek parcel has one recorded biotic community: Petran Montane Conifer Forest, although field reconnaissance also observed Interior Riparian Deciduous Forest and Great Basin Conifer Woodland biotic communities. The upland vegetation is dominated by second-growth ponderosa pine with Gambel oak and New Mexico locust on north-facing slopes, while south-facing slopes are generally scrub live oak woodland with juniper and pinyon pine. Riparian habitat includes species such as boxelder, cottonwood, Arizona alder, and Bonpland willow. Riparian wildlife habitat and raptor nesting and roosting sites are present within the parcel.

The 2017 ecological overview and more recent screening identified a number of other special status species with some potential to occur within the property (either under the ESA, BGEPA, or identified as a Coconino National Forest sensitive species):

- ESA: Little Colorado spinedace (threatened); Mexican spotted owl (threatened); Chiricahua leopard frog (threatened)
- BGEPA: bald eagle; golden eagle
- Coconino National Forest sensitive species: peregrine falcon; Little Colorado sucker; northern goshawk; rock fleabane; roundtail chub; Arizona toad

The dominant surface water feature on the parcel is East Clear Creek, a substantial perennial tributary of the Little Colorado River located approximately 71 river miles downstream (northeast) of the parcel. Analytical results from water quality sampling in 1976 suggest that all chemical constituents in East Clear Creek are within acceptable water quality standards for the support of cold-water fisheries habitat. More recent data from the U.S. Environmental Protection Agency suggest that water quality in East Clear Creek is fully supportive of agricultural use; fish, shellfish, and wildlife protection and propagation; and primary-contact recreation. Other surface water features include minor tributaries that are likely ephemeral to intermittent. Active registered instream flow surface water rights in the Little Colorado watershed sourced from East Clear Creek exist in the parcel as well. In 1993, preliminary analysis was conducted to document a 25-mile portion of East Clear Creek as being eligible with a scenic designation under the Wild and Scenic Rivers Act (U.S. Forest Service 1993). The outstanding remarkable values of this segment include scenic resources and threatened and endangered fish species habitat. The East Clear Creek parcel is within the proposed eligible section. As of 2019, the segment has not been officially designated.

Wildfires in the area in 2018 may have affected the property and surrounding lands.

Hazardous Materials

A Phase 1 environmental site assessment was completed for the property in September 2016, and identified no RECs on the property.

Cultural Resources

A Class III cultural resources inventory performed in 2016 identified three newly recorded archaeological sites, all of which were recommended for inclusion in the NRHP. These archaeological sites point to use by Native Americans and Late Historic period Euro-American uses. In addition, one historical feature was identified just outside the boundary of the parcel.

Key Documents Describing East Clear Creek Parcel

- WestLand Resources Inc. 2016. "Phase I Environmental Assessment Non-Federal Parcel, East Clear Creek, Coconino County, Arizona, Resolution Copper." September 1, 2016 (WestLand Resources Inc. 2016b)
- WestLand Resources Inc. 2016. "A Cultural Resources Inventory of the 633.88-Acre East Clear Creek Parcel, Coconino County, Arizona." September 28, 2016 (Charest 2016c)
- WestLand Resources Inc. 2017. "Ecological Overview for East Clear Creek Parcel, Coconino County, Arizona, Resolution Copper." January 24, 2017 (WestLand Resources Inc. 2017b)

Offered Parcels – Bureau of Land Management

Parcels to be transferred from Resolution Copper to the United States and administered by the BLM are detailed in the following text. Additional details regarding the special status species present on the offered lands being transferred to the BLM are summarized in table B-4 at the end of this appendix.

LOWER SAN PEDRO RIVER PARCEL

Parcel Description

The Lower San Pedro River Parcel is an approximately 3,050-acre parcel located near Mammoth in Pinal County, Arizona (figures B-11 and B-12). It lies within the Basin and Range physiographic province, characterized by mountain ranges trending northwest-southeast, separated by broad alluvial valleys. The parcel is located within one of these valleys, with the Galiuro Mountains to the east and the Santa Catalina Mountains to the south. In November 1988, Congress designated 40 miles and 58,000 acres of the upper San Pedro corridor as the San Pedro Riparian National Conservation Area. The parcel would be administered by the BLM Gila District, Tucson Field Office. The parcel is patented private land for which Swift Land and Cattle, LLC, a subsidiary of Resolution Copper, holds active mining claims.

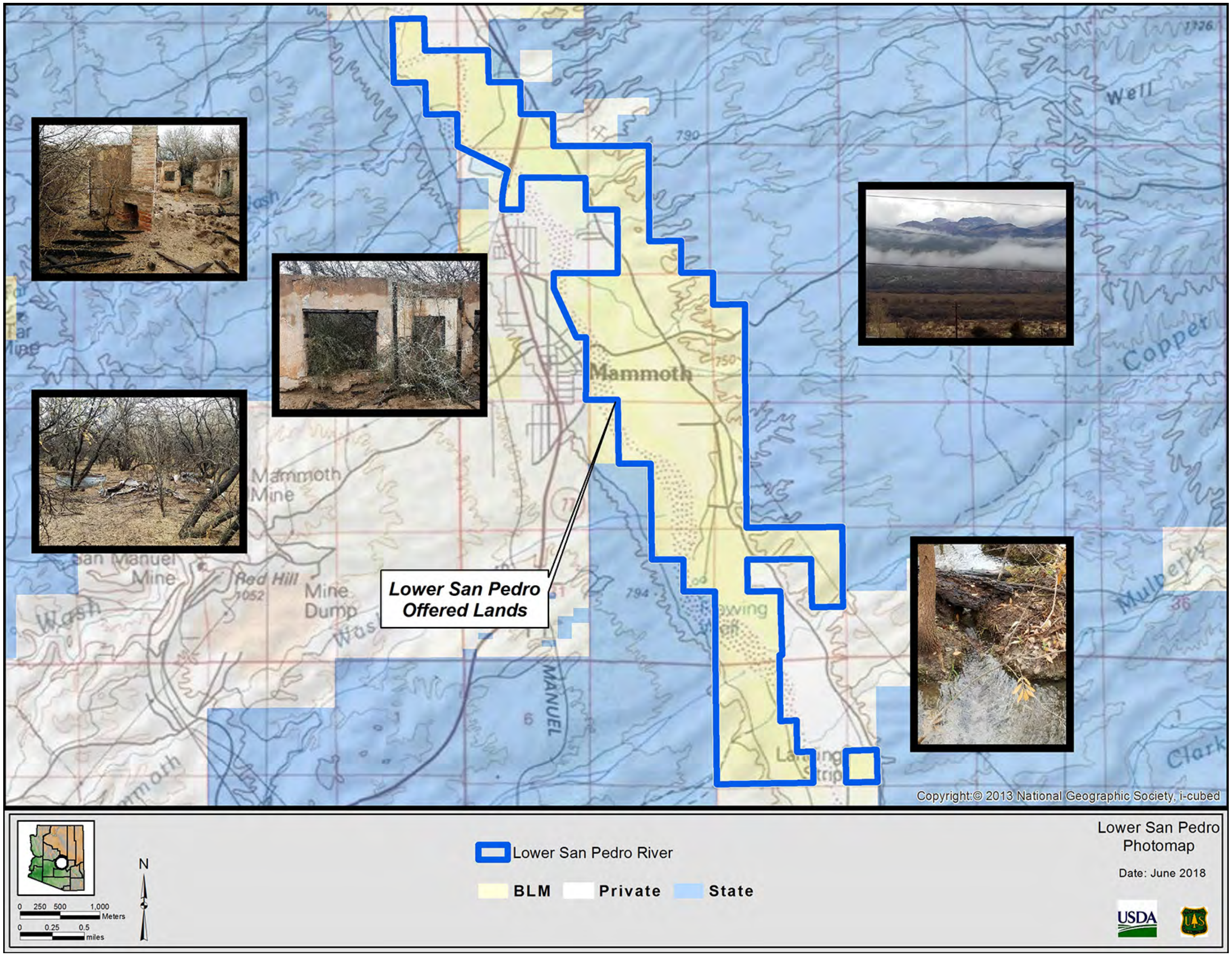

Figure B-11. Lower San Pedro River land exchange parcel

Figure B-12. Photograph of Lower San Pedro River parcel

The Lower San Pedro River Parcel is mostly undeveloped, and the parcel is surrounded by undeveloped land. The developed areas have been primarily used, either currently or historically, for grazing, other agricultural, former residential, or research uses, as seen from abandoned structures, corrals, and farm fields. Approximately 15 percent of the parcel has been cleared of native vegetation. Other known uses of the Lower San Pedro River Parcel are primarily recreational: off-road vehicle use, hunting, and a town park which includes baseball and picnicking facilities. A 1.2-mile-long trail for public access is located within the parcel south of Copper Creek Road. Transfer of the Lower San Pedro River Parcel would render the area unavailable for future housing development.

Portions of the parcel were cultivated from at least 1945 until at least the 1950s when lead and arsenate pesticides and defoliants were historically used on certain crops in Arizona, leading to the possible presence of pesticide residuals in the formerly cultivated soils within the parcel. The parcel is currently managed as an open space by The Nature Conservancy on behalf of Resolution Copper. An on-site storage unit is used for the property manager's gear.

Geological Setting

This parcel is located within the Basin and Range physiographic province, which is characterized by elongated mountain ranges trending northwest-southeast, separated by broad alluvial valleys. The parcel is in a broad alluvial valley with the Galiuro Mountains to the east and the Santa Catalina Mountains to the south. Most of the surface geology of the parcel is Holocene-aged river alluvium. An upland area in the eastern portion of the parcel is mapped as deposits from the Pliocene to Middle Miocene, and the extreme southwestern corner of the parcel is mapped as Quaternary-aged surficial deposits.

Biological and Water Resources

Vegetation on the Lower San Pedro River Parcel includes the Arizona Uplands Subdivision of Sonoran Desertscrub and Sonoran Deciduous Riparian Forest biotic communities. Plant species commonly occurring within the parcel include saguaro, velvet mesquite, creosote bush, several species of cholla cacti, and foothill paloverde. The riparian corridor in the parcel includes more than 800 acres of mesquite woodland that features a wetland fed by a flowing thermal artesian well. The parcel's riparian areas and woodlands provide habitat for a wide variety of wildlife, including many migratory bird species, lowland leopard frogs, and native fish. Other riparian species present include desert willow, Goodding's willow, graythorn, Fremont cottonwood, and the non-native tamarisk.

The 2003 ecological overview identified three special status species with some potential to occur within the property: cactus ferruginous pygmy owl (now delisted); southwestern willow fly-catcher (endangered); and western yellow-billed cuckoo (threatened). More recent screening identified a number of other special status species with some potential to occur within the property (either under the ESA, BGEPA, or identified as a BLM sensitive species):

- ESA: Gila chub (endangered); jaguar (endangered); ocelot (endangered)
- BGEPA: bald eagle; golden eagle
- BLM Gila District sensitive species with known or potential occurrence: peregrine falcon; lowland leopard frog; Arizona grasshopper sparrow; ferruginous hawk; gilded flicker; desert purple martin; Gila longfin dace; desert sucker; Sonora sucker; roundtail chub; monarch butterfly; pale Townsend's big-eared bat; greater western mastiff bat; Allen's lappet-browed or big-eared bat; lesser long-nosed bat; California leaf-nosed bat; cave myotis; Sonoran desert tortoise; desert ornate box turtle

Several large washes exist on the parcel, including Cooper, Mammoth, and Turtle Washes, all tributary to the San Pedro River. The San Pedro River is ephemeral to intermittent along the approximately 53,800-foot reach through the parcel; an uncapped artesian well supports a wetland adjacent to the river channel. The San Pedro River is unique as it is one of only two major rivers that flow north out of Mexico into the United States and is one of the few remaining free-flowing rivers in the Southwest. The unique qualities of the San Pedro River ecosystem have earned this riverine system The Nature Conservancy's designation as one of the "Last Great Places on Earth" and it is one of the more important riparian habitats in the Sonoran and Chihuahuan Deserts.

The parcel contains registered wells that indicate that water levels are generally shallow, at less than 60 feet below the ground surface. Two wells on-site that are monitored by The Nature Conservancy of Arizona indicate that groundwater levels are less than 35 feet below the ground surface. Active surface water rights exist for diverting water for wildlife use on the parcels.

Hazardous Materials

A Phase 1 environmental site assessment was completed for the property in November 2017, and identified several RECs on the property. These include two known fuel releases near the property boundaries (but not within the property), the Town of Mammoth wastewater treatment plant that has permits to discharge pollutants to both the aquifer and surface water upstream of the property, a nearby dry-cleaning operation, and informal dumping. In addition, the former cultivation of the land from at least 1945 until at least the 1950s was noted, as lead and arsenate (arsenic) pesticides and defoliants were historically used on certain crops in Arizona. It is unknown if routine agricultural application of pesticides has occurred on the property, therefore, it is possible that pesticide residuals (chlorinated pesticides, arsenic, and lead) may be present in the formerly cultivated soils on the property. RECS are not

indications that contamination actually exists; these are typically noted so further investigation can take place.

Several cleanups have taken place on the property; additional cleanups are planned in conjunction with the BLM to identify the structures and features desired to remain after completion of the land exchange.

Cultural Resources

A Class III cultural resources inventory performed in 2017 identified 59 archaeological sites within the parcel; 37 of these sites had not been previously identified. Forty sites are recommended eligible for inclusion in the NRHP and one site has been determined eligible. The sites cover a wide range of Prehistoric and Historic periods.

Key Documents Describing Lower San Pedro River Parcel

- The Nature Conservancy. 2016. “7B Ranch Management Plan.” October 1, 2016 (Nature Conservancy 2016)
- Tucson Audubon Society. 2010. “Avian surveys conducted by Audubon Arizona IBA Program at 7B Ranch, Lower San Pedro River, Mammoth, Arizona, 2006–2010.” January 1, 2010 (Wilbor 2010)
- WestLand Resources Inc. 2003. “Ecological Overview: San Pedro River Parcel, Pinal County, Arizona.” September 10, 2003 (WestLand Resources Inc. 2003)
- WestLand Resources Inc. 2017. “A Cultural Resources Inventory of 3,125 Acres of Private Land Along the Lower San Pedro River Near Mammoth, Pinal County, Arizona, Resolution Copper.” April 11, 2017 (Gruner 2017)
- WestLand Resources Inc. 2017. “Phase I Environmental Site Assessment Non-Federal Parcel, Lower San Pedro River, Pinal County, Arizona, Resolution Copper.” November 1, 2017 (WestLand Resources Inc. 2017d)

APPLETON RANCH PARCEL

Parcel Description

The Appleton Ranch Parcel includes approximately 940 acres of non-contiguous private lands south of Elgin in Santa Cruz County, Arizona (figures B-13 and B-14). The parcels are within the Appleton-Whittell Research Ranch and Las Cienegas National Conservation Area. The parcels are to be administered by the BLM Gila District, Tucson Field Office, as part of the Las Cienegas National Conservation Area. The Las Cienegas National Conservation Area, established in 2000, is a 45,000-acre conservation area containing cottonwood-willow riparian forests and marshlands associated with Cienega Creek, rolling grasslands, and woodlands. Established in 1969 by the Appleton family in partnership with the National Audubon Society, Forest Service, and BLM, the Appleton-Whittell Research Ranch is a sanctuary for native plants and animals and a research facility for the study of grassland ecosystems. The ranch is currently managed by the National Audubon Society.

Figure B-13. Photograph of Appleton Ranch parcel

The Appleton Ranch Parcels are unpatented private land and have no active mining claims. Federal and State lands surrounding the area are used principally for livestock grazing as well as dispersed recreational activities including hunting, camping, off-road vehicle use, and hiking. Grazing operations were the primary use until 1969, when the property owner ceased ranching operations to enter into agreements with the BLM, Forest Service, and Audubon Society to use the Research Ranch to study grassland ecology. Although technically not part of the Research Ranch, management on the parcels has been essentially the same: no livestock grazing or other ranching operations, limited residential use, and low-impact ecological study.

Remaining structures within the parcel include a few windmills, wells, and numerous small earthen-bermed reservoirs. These features are accessible via primitive dirt roads from the Research Ranch primitive road network. Additionally, one area was used for residential purposes from the 1980s until 2002 when it was destroyed by a fire. The fire debris was disposed of off-site, leaving only the house foundation and septic system.

Geological Setting

These parcels are located along the streambeds and adjacent upland areas of Post, Vaughn, and O'Donnell Canyons. The upland areas drained by the three on-site streams are known as the Canelo Hills, rolling terrain that include the Appleton Ranch parcels. The Canelo Hills are in the southern Basin and Range physiographic province and are composed of volcanic and sedimentary rocks. A veneer of soil overlies the bedrock on the upland areas, and eroded material from these uplands has accumulated as alluvium in canyon bottoms. The easternmost parcel's surface geology is mapped as surficial deposits that are

predominantly from the Early Pleistocene to Late Pliocene; the western portion is mapped as deposits dating from the Pliocene to Middle Miocene; and the southeastern corner is mapped as sedimentary rocks from the Middle Miocene to Oligocene. The other two parcels are mapped as deposits from the Pliocene to Middle Miocene.

Biological and Water Resources

The ranch contains more than 90 species of native grass and 480 native plant species and is used by more than 200 species of birds for wintering, breeding, or migratory habitat.

Biotic communities within the parcels include Semidesert Grassland and Madrean Evergreen Oak Woodland. Grasslands are much more extensive than are the oak woodlands. The grassland varies markedly in species composition, density, and structure in the northern part of the Appleton Ranch Parcel, with short-grass grasslands found on south-facing slopes, medium-sized grass stands in swales and north-facing ridges, and tall-grass stands of sacaton in the broader floodplains along several of the washes. Woody vegetation is present in some upland areas as juniper woodlands, and along watercourses as mesquite bosques with very limited stands of cottonwood and desert willow. Transfer of the parcels to public ownership would ensure seamless management of the surrounding ecological preserve and contribute to its continued protected status. Primary values of the surrounding Research Ranch that would become extended to Appleton Ranch through acquisition include the following: to provide a wildlife sanctuary that is ungrazed by cattle, conduct or promote ecological research, and to provide education about sustainable land management. Large mammals such as pronghorn, deer, peccaries, and coyotes are present within the parcel and pass through often.

The 2004 ecological overview identified 13 special status species with some potential to occur within the property: Huachuca water umbel (endangered); Canelo Hills ladies' tresses (endangered); Gila chub (endangered); Gila topminnow (endangered); desert pupfish (endangered); Chiricahua leopard frog (threatened); Mexican spotted owl (threatened); bald eagle (since delisted but still protected under the BGEPA); western yellow-billed cuckoo (threatened); ocelot (endangered); jaguar (endangered); lesser long-nosed bat (since delisted); and Huachuca springsnail (candidate species, not listed). More recent screening identified a number of other special status species with some potential to occur within the property (either under the ESA, BGEPA, or identified as a BLM sensitive species):

- ESA: northern Mexican gartersnake (threatened)
- BGEPA: bald eagle; golden eagle
- BLM Gila District sensitive species with known or potential occurrence: peregrine falcon; lowland leopard frog; Arizona grasshopper sparrow; ferruginous hawk; gilded flicker; Gila longfin dace; desert sucker; Sonora sucker; roundtail chub; monarch butterfly; pale Townsend's big-eared bat; greater western mastiff bat; Allen's lappet-browed or big-eared bat; lesser long-nosed bat; California leaf-nosed bat; cave myotis; Sonoran desert tortoise; desert ornate box turtle; western burrowing owl

The Appleton Ranch parcels are located along streambeds and adjacent upland areas of Post, Vaughn, and O'Donnell Canyons, all of which flow north-northeast toward the Babocomari River approximately 1.5 miles north of the closest parcel boundaries. The Babocomari River is an ephemeral to perennial tributary to the perennial San Pedro River, which flows north and northwest to join the Gila River, eventually flowing westward across Arizona to the Colorado River.

Groundwater levels on or near the property appear at relatively shallow depths (i.e., generally less than 100 feet below surface). Surface water rights exist for stock ponds and erosion-control structures on the Appleton Ranch parcels.

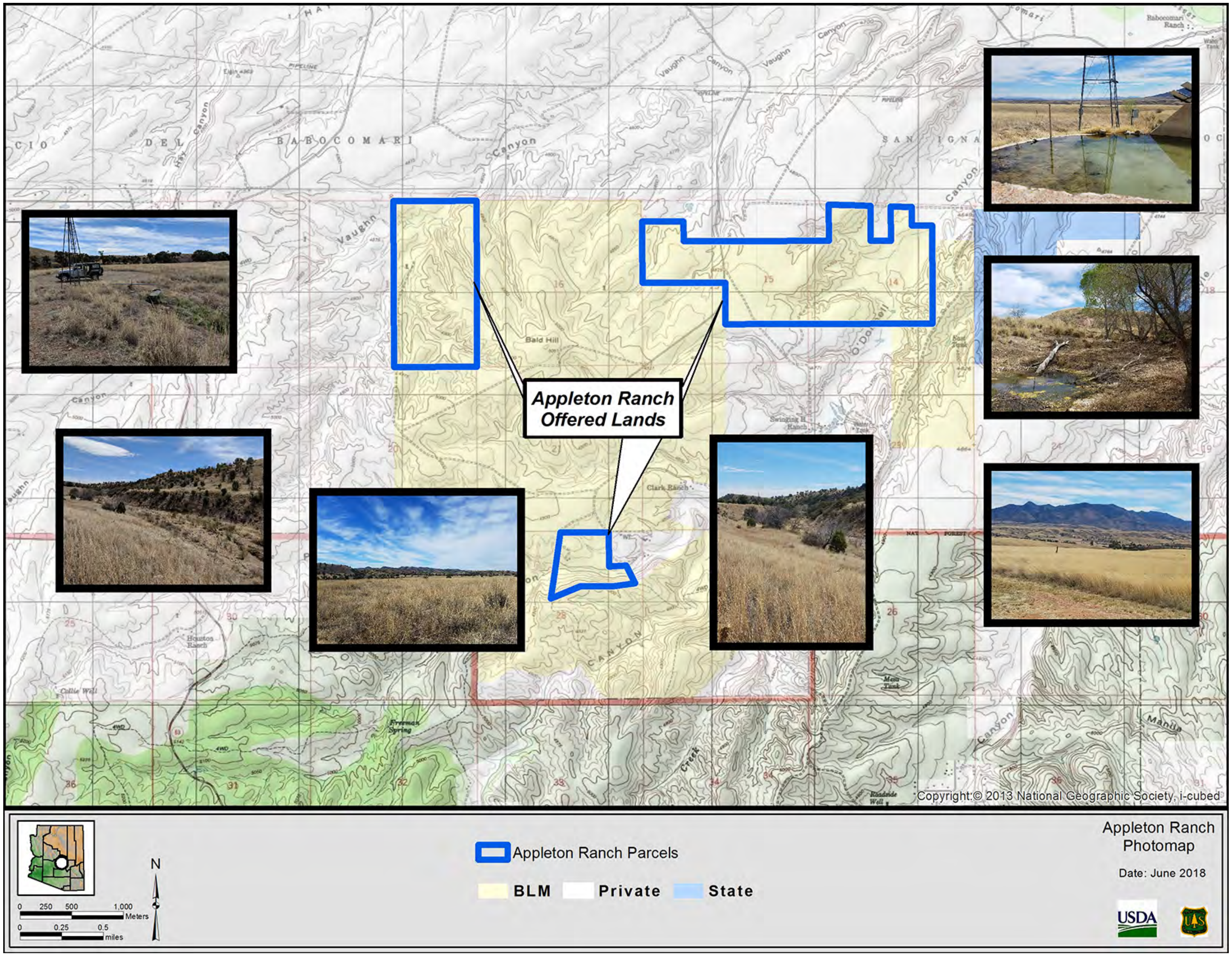

Figure B-14. Appleton Ranch land exchange parcels

Hazardous Materials

A Phase 1 environmental site assessment was completed for the property in September 2016, and identified no RECs on the property.

Cultural Resources

A Class III cultural resources inventory performed in 2015 identified three archaeological sites within the parcel, related to Native American resource procurement and processing activities and historic-era ranching. Two sites were recommended eligible for inclusion in the NRHP.

Key Documents Describing Appleton Ranch Parcels

- Breckenfeld, D.J., and D. Robinett, Natural Resources Conservation Service. 2001. “Soil and Range Resource Inventory of the National Audubon Society Appleton-Whittell Research Ranch, Santa Cruz County, Arizona.” April 1, 2001 (Breckenfeld and Robinett 2001)
- Cogan, R.C., Conservation Coordinator, Appleton-Whittell Research Ranch, National Audubon Society. 2012. “Herpetofauna of the Appleton-Whittell Research Ranch.” November 1, 2012 (Cogan 2012)
- McLaughlin, S.P., E.L. Geiger, and J.E. Bowers. 2001. “Flora of the Appleton-Whittell Research Ranch, northeastern Santa Cruz County, Arizona.” January 1, 2001 (McLaughlin et al. 2001)
- WestLand Resources Inc. 2004. “Ecological Overview Appleton Ranch Parcel, Santa Cruz County, Arizona.” May 26, 2004 (WestLand Resources Inc. 2004b)
- WestLand Resources Inc. 2015. “A Cultural Resources Inventory of 940 Acres Within the Appleton-Whittell Research Ranch for Resolution Copper Mining, LLC.” December 1, 2015 (Daughtrey 2015)
- WestLand Resources Inc. 2016. “Phase I Environmental Site Assessment Non-Federal Parcel, Appleton Ranch, Santa Cruz County, Arizona Resolution Copper.” September 1, 2016 (WestLand Resources Inc. 2016d)

DRIPPING SPRINGS PARCEL

Parcel Description

The Dripping Springs Parcel is a 160-acre parcel located northeast of Kearny in Gila and Pinal Counties, Arizona, in the Basin and Range physiographic province (figures B-15 and B-16). It lies within a rugged upland area northeast of the Gila River, which is the main drainage feature for the area. The parcel, situated in the Dripping Spring Mountains near Tam O’Shanter Peak and Steamboat Mountain, is almost completely surrounded by BLM-administered lands, with some adjacent Arizona State Land Department–administered State Trust land. The parcel would be administered by the BLM Gila District, Tucson Field Office. The parcel is unpatented private land and has no active mining claims.

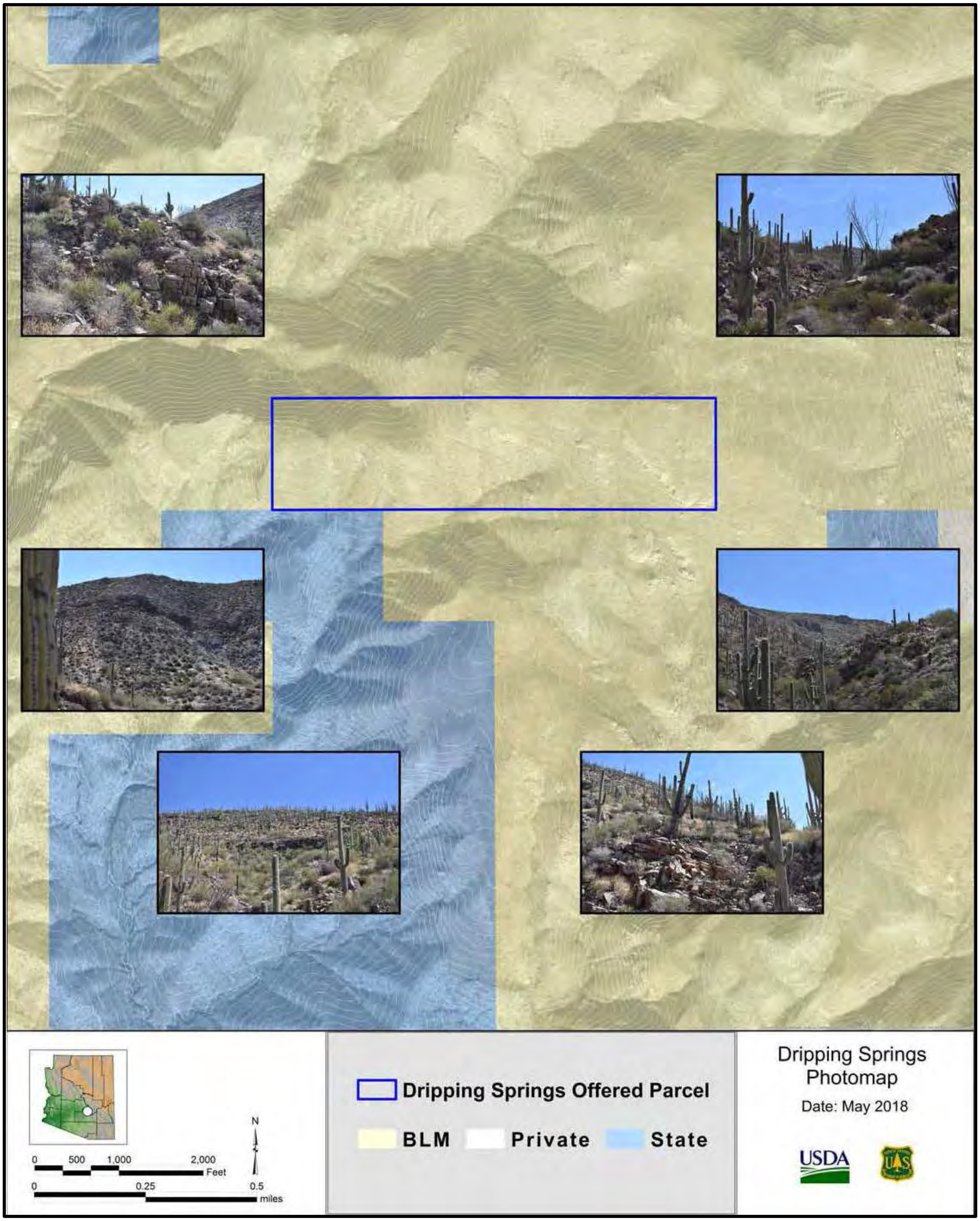

Figure B-15. Dripping Springs land exchange parcel

Figure B-16. Photograph of Dripping Springs parcel

The parcel's abundant rock formations are known for offering recreational rock-climbing opportunities. The Arizona State Parks Board, recognizing the value of this climbing resource, has taken preliminary steps toward the creation of a state park in this location. Hunting is also a permitted recreational activity in the area. Historically the areas surrounding the parcel were the focus of prospecting, mining, and settlement during the Historic period; however, limited homesites, mines, or other features have been found within the Dripping Springs Parcel. In general, the parcel is characterized as undeveloped open space, with past land use limited to small-scale mine exploration, intermittent hunting and recreational shooting, and possibly hiking. Land use in the surrounding areas appears to be similar to the Dripping Springs Parcel but may also include livestock grazing. Vehicular access to the parcel is unavailable as no road accesses the area. Because the property is only accessible by overland hiking across rugged terrain, the parcel has been effectively isolated from human use and has not been subjected to overuse by hikers, off-road vehicle use, hunters, miners, or ranchers. Transfer of management of the Dripping Springs Parcel to the BLM would require a permit to perform recreational and resource use activities generating significant noise, light, and dust disturbances.

Geological Setting

This parcel is in the Dripping Spring Mountains northeast of Kearny, which is a rugged upland area northeast of the Gila River, the main drainage feature for the region. Notable peaks are Steamboat Mountain to the west and Tam O'Shanter Peak to the southeast. This parcel is within the Basin and Range

physiographic province and the Dripping Spring Mountains have extensive and complex fault systems composed of tilted fault blocks. The surface geology of the parcel is predominantly sedimentary rocks of Precambrian age (Middle Proterozoic). A fault bisects the parcel and defines the boundary between two tilted fault blocks. The western portion of the parcel is mapped as sedimentary rocks from the Mississippian, Devonian, and Cambrian.

Biological and Water Resources

Vegetation on the parcel encompasses two biotic communities: Arizona Upland Subdivision of the Sonoran Desertscrub and Semi-desert Grassland. The western portion of the parcel includes both biotic communities, whereas the eastern portion is entirely grasslands. Commonly found plant species within the Dripping Springs Parcel include saguaro, paloverde, jojoba, velvet mesquite, desert hackberry, hopbush, brittlebush, cholla, and prickly pear cacti. Grassland species found include desert spoon, Palmer’s agave, catclaw acacia, scrub live oak, beargrass, one-seed juniper, threeawn grasses, sideoats grama grass, black grama grass, curly mesquite grass, bullgrass, and broom snakeweed. Groupings of limestone endemics were also noted within the parcel including sandpaper bush, Mariola, crucifixion thorn, desert zinnia, and beebush. The xeric washes on the parcel support dense velvet mesquite and catclaw mimosa.

The 2016 ecological overview and more recent screening identified a number of other special status species with some potential to occur within the property (either under the ESA, BGEPA, or identified as a BLM sensitive species):

- ESA: western yellow-billed cuckoo (threatened); ocelot (endangered); jaguar (endangered); southwestern willow fly-catcher (endangered)
- BGEPA: bald eagle; golden eagle
- BLM Gila District sensitive species with known or potential occurrence: peregrine falcon; gilded flicker; monarch butterfly; pale Townsend’s big-eared bat; greater western mastiff bat; Allen’s lappet-browed or big-eared bat; lesser long-nosed bat; California leaf-nosed bat; cave myotis; Sonoran desert tortoise; pinyon jay; desert purple martin

No surface water features appear to be present within the Dripping Springs Parcel, with the exception of very minor ephemeral headwater drainage features that are tributary to the Gila River.

Hazardous Materials

A Phase 1 environmental site assessment was completed for the property in June 2015, and identified no RECs on the property. Historical mine features were noted during the work, but while there is potential for these mine features to impact groundwater or produce acid mine drainage, no discoloration or distressed vegetation was noted around the existing features. In addition, potential for impacts on surface or groundwater by contact with mineralized rock is not considered likely.

Cultural Resources

A Class III cultural resources inventory performed in 2016 identified four newly recorded archaeological sites, two of which were recommended for inclusion in the NRHP. These archaeological sites point to use by Native Americans, and Late Historic period Euro-American uses.

Key Documents Describing Dripping Springs Parcel

- WestLand Resources Inc. 2015. “Phase I Site Assessment Non-Federal Parcel - Dripping Springs Gila County, Arizona.” June 1, 2015 (WestLand Resources Inc. 2015a)

- WestLand Resources Inc. 2016. "A Cultural Resources Inventory of the 159.64-Acre Dripping Spring Parcel, Gila and Pinal Counties, Arizona." September 28, 2016 (Charest 2016a)
- WestLand Resources Inc. 2016. "Ecological Overview Dripping Springs Parcel Gila and Pinal Counties, Arizona: Resolution Copper." December 1, 2016 (WestLand Resources Inc. 2016a)

Town of Superior Lands

PARCEL DESCRIPTION

If requested by the Town of Superior, Section 3003 additionally authorizes and directs the transfer of 545 acres of NFS lands to the Town of Superior (figure B-17). At this time, the Town of Superior has not requested the transfer.

Figure B-17. Photograph of Town of Superior parcel

The Forest Service–administered lands to be conveyed to the Town of Superior include a 30-acre parcel known as Fairview Cemetery and 250 acres contained in four parcels known as the Superior Airport Contiguous Parcels. In addition, the Town of Superior lands include a Federal reversionary interest to a 265-acre Superior Airport parcel. The Superior Airport parcel was originally owned by the Federal Government, then deeded to Pinal County, and subsequently conveyed to the Town of Superior with the condition that it could only be used as an airstrip. Any other use would cause the property to revert to Federal land (the reversionary interest). As part of the land exchange, the Federal reversionary interest would be removed, after which time the parcel could be used for non-airport purposes.

Wildlife Species Occurrence on Offered Lands

The following tables contain analysis of which special status species occur on lands managed by either Tonto National Forest (see table B-2), Coconino National Forest (see table B-3), or BLM (see table B-4). Each of these administrative jurisdictions has a separate list of species that are considered to have special status.

Plant Species Occurrence on Offered Lands

Special status plants also occur on the various parcels and are listed in table B-5. Each of these administrative jurisdictions has a separate list of species that are considered to have special status. The jurisdictions are also concerned with noxious weeds and their presence for management goals. The likelihood of occurrence for the noxious and invasive weeds are shown in table B-6.

Table B-2. Special status wildlife species for offered lands under Tonto National Forest jurisdiction

Unless otherwise noted, range or habitat information is from the following sources: Arizona Heritage Data Management System (Arizona Game and Fish Department 2018a); USFWS Arizona Ecological Services Field Office (U.S. Fish and Wildlife Service 2016b); Tonto National Forest Final Assessment (U.S. Forest Service 2017d); Tonto National Forest Threatened, Endangered and Sensitive Species Abstracts (Tonto National Forest 2000); NatureServe (NatureServe 2018); Reptiles and Amphibians of Arizona (Brennan 2008); eBird (2018)

Common Name (*Scientific Name*)	Status*	HDMS Records within 2 miles	Baseline Data Records	Other Records (eBird, SWCA, or Forest Service Site Visits, Reptiles of Arizona)	Habitat Components (Elevation, Soils, Vegetation Association, Slope, Aspect, etc.)	Geographical Range in Arizona	Likelihood of Occurrence in Offered Lands Parcels
Amphibians							
Western barking frog (*Craugastor augusti cactorum*)	TNF: S	No	No	No	Species prefers outcrops or cave on rocky slopes in oak/pine-oak associations; elevational range of 4,200–6,200 feet above mean sea level (amsl)	Occurs in rocky outcrops in Cochise and southern Pima and Santa Cruz Counties, in the Quinlan, Santa Rita, Patagonia, Huachuca, and Pajarito mountain ranges	Unlikely to occur
Chiricahua leopard frog (*Lithobates chiricahuensis*)	ESA: T (Gila, Pinal, Yavapai Counties)	No	No	No	Species is known from mid-elevation wetland communities such as tanks, lakes, reservoirs, streams, and rivers; often surrounded by an arid environment. Elevational range of 3,281–8,890 feet.	Occurs along the Mogollon Rim and in mountainous areas of southeastern Arizona	Possible site: Turkey Creek
Northern leopard frog (*Lithobates pipiens*)	TNF: S	No	No	No	Range of habitats that includes grasslands, brush land, and forests, usually in permanent water; elevational range of 2,640–9,155 feet amsl	Found in northern and central Arizona	Unlikely to occur
Lowland leopard frog (*Lithobates yavapaiensis*)	TNF: S	No	No	No	Aquatic systems in elevations ranging from 480–6,200 feet amsl; species is found using a variety of habitats both natural and human-made	Occurs in central and southeastern Arizona	Possible sites: Apache Leap, Cave Creek, Tangle Creek, Turkey Creek
Birds							
Northern goshawk (*Accipiter gentilis*)	TNF: S	Yes, Turkey Creek	No	No	Species is found in wide variety of forest associations including deciduous, coniferous and mixed forests; prefers mature forests for breeding in elevations ranging from 4,750–9,120 feet amsl	Occurs throughout Arizona	Possible site: Turkey Creek
Golden eagle (*Aquila chrysaetos*)	BGEPA: Yes	No	Yes, Apache Leap (WestLand Resources Inc. 2017c)	eBird	Species prefers mountainous areas, nesting occurs at elevations between 4,000–10,000 feet amsl	Occurs throughout Arizona	Known site: Cave Creek; possible sites: Apache Leap, Tangle Creek, Turkey Creek
Western yellow-billed cuckoo (DPS) (*Coccyzus americanus*)	ESA: T (All Arizona counties)	Yes, Apache Leap, Tangle Creek	No	eBird	Typically found in riparian woodland vegetation (cottonwood [*Populus* spp.], willow [*Salix* spp.], or saltcedar [*Tamarix* spp.) at elevations below 6,600 feet amsl. Dense understory foliage appears to be an important factor in nest site selection.	Occurs throughout Arizona	Known site: Cave Creek; possible sites: Tangle Creek, Turkey Creek,
Southwestern willow flycatcher (*Empidonax traillii extimus*)	ESA: E (All counties except Navajo County)	No	No	No	Found in dense riparian habitats along streams, rivers, and other wetlands where cottonwood (*Populus* spp.), willow (*Salix* spp.), boxelder (*Acer negundo*), saltcedar (*Tamarix* spp.), Russian olive (*Elaeagnus angustifolia*), buttonbush (*Cephalanthus* spp.), and arrowweed (*Pluchea sericea*) are present. Nests are found in thickets of trees and shrubs, primarily those that are 13 to 23 feet tall, among dense, homogeneous foliage. Habitat occurs at elevations below 8,500 feet amsl.	Occurs throughout Arizona	Possible sites: Cave Creek, Tangle Creek, Turkey Creek
American peregrine falcon (*Falco peregrinus anatum*)	TNF: S	No	Yes, Apache Leap South (WestLand Resources Inc. 2017c)	eBird: Cave Creek, Apache Leap	Species is found near cliffs overlooking habitats that support large numbers of birds; elevational range from 400–9,000 feet amsl	Occurs throughout Arizona	Known sites: Cave Creek, Apache Leap; possible sites: Tangle Creek, Turkey Creek
Yellow-eyed junco (*Junco phaeonotus*)	TNF: S	No	No	No	Habitat consists of open coniferous forest and pine-oak associations	Occurs in central and southeastern Arizona	Unlikely to occur
Sulphur-bellied flycatcher (*Myiodynastes luteiventris*)	TNF: S	No	No	No	Preferred habitat includes sycamore-walnut canyons; species only present during breeding season	Occurs in southeast and central Arizona	Unlikely to occur

Common Name (*Scientific Name*)	Status*	HDMS Records within 2 miles	Baseline Data Records	Other Records (eBird, SWCA, or Forest Service Site Visits, Reptiles of Arizona)	Habitat Components (Elevation, Soils, Vegetation Association, Slope, Aspect, etc.)	Geographical Range in Arizona	Likelihood of Occurrence in Offered Lands Parcels
Yuma Ridgeway's rail (*Rallus longirostris yumanensis*)	ESA: E (Gila, La Paz, Maricopa, Mohave, Pinal, and Yuma Counties)	No	No	No	In Arizona, found at elevations below 4,500 feet amsl in freshwater marshes, which are often dominated by cattails (*Typha* spp.), bulrushes (*Isolepis* spp.), and sedges (*Carex* spp.).	Occurs in western and central Arizona	Unlikely to occur
Mexican spotted owl (*Strix occidentalis lucida*)	ESA: T (All counties except La Paz and Yuma Counties)	No	No	No	Found in mature montane forests and woodlands and steep, shady, wooded canyons. Can also be found in mixed-conifer and pine-oak vegetation types; generally nests in older forests of mixed conifers or ponderosa pine–Gambel oak. Nests in live trees on natural platforms (e.g., dwarf mistletoe [*Arceuthobium* spp.] brooms), snags, and canyon walls at elevations between 4,100 and 9,000 feet amsl.	Occurs throughout Arizona, except La Paz and Yuma Counties	Possible site: Turkey Creek
Fish							
Desert sucker (*Catostomus clarki*)	TNF: S	Yes, Apache Leap, Cave Creek, Tangle Creek, Turkey Creek	No	No	Species is found in flowing pools of streams and rivers with a gravel substrate; elevational range of 480–8,840 feet amsl	Occurs in central, southern, and southeastern Arizona	Possible sites: Tangle Creek, Turkey Creek
Sonora sucker (*Catostomus insignis*)	TNF: S	Yes, Apache Leap, Cave Creek, Tangle Creek, Turkey Creek	No	No	Found in a variety of habitats from warm rivers to cool streams, prefers gravelly or rocky pools in elevations ranging from 1,210–8,730 feet amsl	Occurs in central, southern, and southeastern Arizona	Possible sites: Turkey Creek
Desert pupfish (*Cyprinodon macularius*)	ESA: E (Cochise, Gila, Graham, Maricopa, Pima, Santa Cruz, and Yavapai Counties)	No	No	No	Found in shallow waters of springs, marshes and small streams, prefers soft substrates and clear water; elevational range of 1,200–3,450 feet amsl	Occurs in Cochise, Gila, Graham, Maricopa, Pima, Santa Cruz, and Yavapai Counties	Unlikely to occur
Gila chub (*Gila intermedia*)	ESA: E (Cochise, Coconino, Gila, Graham, Greenlee, Pima, Pinal, Santa Cruz, and Yavapai Counties)	No	No	No	Normally found in smaller headwater streams, cienegas, and springs or marshes of the Gila River Basin at elevations between 2,720 and 5,420 feet amsl.	Occurs in Cochise, Coconino, Gila, Graham, Greenlee, Pima, Pinal, Santa Cruz, and Yavapai Counties	Possible sites: Tangle Creek, Turkey Creek
Headwater chub (*Gila nigra*)	TNF: S	No	No	No	Species is found in the middle to headwater reaches of medium-sized streams with large pools and cover; elevational range of 92–2,000 feet amsl	Occurs in Gila, Graham, and Yavapai Counties	Possible sites: Tangle Creek, Turkey Creek
Roundtail chub (*Gila robusta*)	TNF: S	No	No	No	Species prefers cool to warm water in mid-elevation streams and rivers with pools up to 6.6 feet deep near flowing water. Cover consists of boulders, tree roots, deep water and submerged vegetation. Elevational range of 1,210–7,220 feet amsl	Occurs in Apache, Coconino, Gila, Graham, Greenlee, La Paz, Maricopa, Mohave, Navajo, Pinal, and Yavapai Counties	Possible sites: Tangle Creek, Turkey Creek
Spikedace (*Meda fulgida*)	ESA: E (Apache, Cochise, Coconino, Gila, Graham, Greenlee, Maricopa, Pinal, and Yavapai Counties)	No	No	No	Found in medium-sized to large perennial streams, where it inhabits moderate-velocity to fast waters over gravel and rubble substrates, typically at elevations below 6,000 feet amsl.	Occurs in Apache, Cochise, Coconino, Gila, Graham, Greenlee, Maricopa, Pinal, and Yavapai Counties	Possible sites: Tangle Creek, Turkey Creek
Gila topminnow (incl. Yaqui) (*Poeciliopsis occidentalis*)	ESA: E (Cochise, Gila, Graham, Maricopa, Pima, Pinal, Santa Cruz, and Yavapai Counties)	No	No	No	Occurs in small streams, springs, and cienegas at elevations below 4,500 feet amsl, primarily in shallow areas with aquatic vegetation and debris for cover	Occurs in Cochise, Gila, Graham, Maricopa, Pima, Pinal, Santa Cruz, and Yavapai Counties	Unlikely to occur
Colorado pikeminnow (*Ptychocheilus lucius*)	ESA: E (Gila, Maricopa, and Yavapai Counties)	No	No	No	Juveniles prefer slackwater, backwater and side channels with little or no flow and silty substrates; adults utilize turbid, deep and fast flowing waters. Species was reintroduced at an elevation of 1,960 feet amsl.	Occurs in Gila, Maricopa, and Yavapai Counties	Unlikely to occur

Common Name (*Scientific Name*)	Status*	HDMS Records within 2 miles	Baseline Data Records	Other Records (eBird, SWCA, or Forest Service Site Visits, Reptiles of Arizona)	Habitat Components (Elevation, Soils, Vegetation Association, Slope, Aspect, etc.)	Geographical Range in Arizona	Likelihood of Occurrence in Offered Lands Parcels
Loach minnow (*Tiaroga cobitis*)	ESA: E (Apache, Cochise, Coconino, Gila, Graham, Greenlee, Pinal, and Yavapai Counties)	No	No	No	Found in small to large perennial creeks and rivers, typically in shallow, turbulent riffles with cobble substrate, swift currents, and filamentous algae at elevations below 8,000 feet amsl	Occurs in Apache, Cochise, Coconino, Gila, Graham, Greenlee, Pinal, and Yavapai Counties	Unlikely to occur
Razorback sucker (*Xyrauchen texanus*)	ESA: E (Coconino, Gila, Graham, Greenlee, La Paz, Maricopa, Mohave, Pinal, Yavapai, and Yuma Counties)	No	No	No	Found in backwaters, flooded bottomlands, pools, side channels, and other slower moving habitats at elevations below 6,000 feet amsl	Occurs in Coconino, Gila, Graham, Greenlee, La Paz, Maricopa, Mohave, Pinal, Yavapai, and Yuma Counties	Unlikely to occur
Invertebrates							
Netwing midge (*Agathon arizonicus*)	TNF: S	No	No	No	Confined to areas in the immediate vicinity of rapidly flowing streams	Occurs in Gila County in Arizona	Unlikely to occur
Parker's cylloepus riffle beetle (*Cylloepus parkeri*)	TNF: S	No	No	No	Habitat consists of small, rocky streams	Occurs in Yavapai County, Arizona	Possible sites: Cave Creek, Tangle Creek
A mayfly (*Fallceon eatoni*)	TNF: S	No	No	No		Occurs in Gila County, Arizona	Unlikely to occur
Fossil springsnail (*Pyrgulopsis simplex*)	TNF: S	No	No	No	Habitat is only present at headsprings and upper section of the outflow, generally found on rocks or aquatic macrophytes in moderate current	Occurs in Gila and Yavapai Counties, Arizona	Unlikely to occur
A caddisfly (*Wormaldia planae*)	TNF: S	No	No	No		Occurs in Gila and Yavapai Counties	Unlikely to occur
Mammals							
Sonoran pronghorn (*Antilocapra americana sonoriensis*)	ESA: ENE (La Paz, Maricopa, Pima, Pinal, Santa Cruz and Yuma Counties)	No	No	No	Found in Sonoran desertscrub within broad, intermountain, alluvial valleys with creosote (*Larrea tridentata*)–bursage (*Ambrosia* spp.) and palo verde–mixed cacti associations at elevations between 2,000 and 4,000 feet amsl.	Occurs in southwestern Arizona	Unlikely to occur
Mexican gray wolf (*Canis lupus baileyi*)	ESA: E (Apache and Greenlee Counties)	No	No	No	Vegetation type not important, species mostly needs sufficient prey such as deer and elk. Reintroduction areas are typically rugged lands in coniferous forest. Elevational range of 3,000–12,000 feet amsl.	Occurs in Apache and Greenlee Counties, reintroductions are occurring in Apache County. All packs are currently located on the Apache-Sitgreaves National Forests (AGFD 2018a).	Unlikely to occur
Pale Townsend's big-eared bat (*Corynorhinus townsendii pallescens*)	TNF: S	Yes, Apache Leap, Cave Creek, Tangle Creek, Turkey Creek	No	No	In summer the species is found in caves and mines in elevations ranging from 550–7,520 feet amsl; in winter the species is found in cold caves, lava tubes, and mines in higher elevations than summer	Occurs throughout Arizona	Possible sites: Apache Leap, Cave Creek, Tangle Creek, Turkey Creek
Spotted bat (*Euderma maculatum*)	TNF: S	No	No	No	Habitat can vary widely from dry deserts to conifer forest, prefer to roost in crevices and cracks in cliff faces; elevational range of 110–8,670 feet amsl	Occurs in Yuma and Maricopa Counties, and eastern Arizona	Possible sites: Apache Leap, Cave Creek, Tangle Creek, Turkey Creek
Allen's lappet-browed or big-eared bat (*Idionycteris phyllotis*)	TNF: S	No	No	No	Found in ponderosa pine, pinyon-juniper, Mexican woodland and riparian areas with cottonwoods, sycamores and willows, also have records from desertscrub and white fir habitats; elevational range of 1,320–9,800 feet amsl	Occurs throughout Arizona except for deserts in southwestern Arizona	Possible sites: Apache Leap, Cave Creek, Tangle Creek, Turkey Creek
Western red bat (*Lasiurus blossevillii*)	TNF: S	No	No	No	Habitat consists of riparian and wooded areas, typically roosts in cottonwood trees; elevational range of 1,900–7,200 feet amsl	Occurs south-central to southern and southeastern Arizona	Possible sites: Apache Leap, Cave Creek, Tangle Creek, Turkey Creek

Common Name (*Scientific Name*)	Status*	HDMS Records within 2 miles	Baseline Data Records	Other Records (eBird, SWCA, or Forest Service Site Visits, Reptiles of Arizona)	Habitat Components (Elevation, Soils, Vegetation Association, Slope, Aspect, etc.)	Geographical Range in Arizona	Likelihood of Occurrence in Offered Lands Parcels
Ocelot (*Leopardus [Felis] pardalis*)	ESA: E (Cochise, Gila, Graham, Maricopa, Pima, Pinal, and Santa Cruz Counties)	No	No	No	In Arizona, this species has typically been observed in subtropical thorn forest, thornscrub, and dense, brushy thickets at elevations below 8,000 feet amsl and is often found in riparian bottomlands. The critical habitat component is probably dense cover near the ground and complete avoidance of open country.	Occurs in Cochise, Gila, Graham, Maricopa, Pima, Pinal, and Santa Cruz Counties	Unlikely to occur
Jaguar (*Panthera once*)	ESA: E (Cochise, Pima, and Santa Cruz Counties)	No	No	No	Variety of habitats, prefers lowland wet habitats but also occurs in drier habitats such as oak-pine woodlands; elevational range of sightings in Arizona were from 5,200–5,700 feet amsl	Occurs in Cochise, Pima, and Santa Cruz Counties	Unlikely to occur
Reptiles							
Sonoran Desert tortoise (*Gopherus morafkai*)	TNF: S	No	No	No	Habitat includes Mojave desert scrub to semidesert grassland and interior chaparral; elevational range of 510–5,300 feet amsl	Occurs in the southern and southwest part of Arizona	Possible sites: Apache Leap, Cave Creek, Tangle Creek
Northern Mexican gartersnake (*Thamnophis eques megalops*)	ESA: T (All counties except Maricopa and Yuma Counties)	No	No	No	Species prefers cienegas, streams and rivers in habitats ranging from upland Sonoran desertscrub to montane coniferous forests; elevational range of 1,000–6,700 feet amsl	Occurs throughout Arizona except Maricopa and Yuma Counties	Possible site: Turkey Creek
Narrow-headed gartersnake (*Thamnophis rufipunctatus*)	ESA: T (Apache, Coconino, Gila, Graham, Greenlee, Navajo, and Yavapai Counties)	No	No	No	Species prefers pinyon-juniper and pine-oak woodlands, ranging into ponderosa pine at elevations between 2,440–8,080 feet amsl; species needs permanent water source	Occurs in Apache, Coconino, Gila, Graham, Greenlee, Navajo, and Yavapai Counties	Possible site: Turkey Creek
Bezy's night lizard (*Xantusia bezyi*)	TNF: S	No	No	No	Species prefers rocky slopes in upland Sonoran desertscrub and chaparral vegetation types; elevational range of 2,400–5,800 feet amsl	Occurs in Gila, Pinal, and Maricopa Counties	Possible site: Apache Leap

*Status Definitions

Endangered Species Act (ESA):

E = Endangered. Endangered species are those in imminent jeopardy of extinction. The ESA specifically prohibits the take of a species listed as endangered. Take is defined by the ESA as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to engage in any such conduct.

T = Threatened. Threatened species are those that are likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

ENE = Reintroduced populations designated as Experimental – Nonessential, under ESA.

Tonto National Forest (TNF):

S = Sensitive. Species identified by a Regional Forester for which population viability is a concern, as evidenced by: a. significant current or predicted downward trends in population number or density. B. Significant current or predicted downward trends in habitat capability that would reduce a species' existing distribution.

Bald and Golden Eagle Protection Act (BGEPA):

Yes = A species protected by a United States Federal statute that protects two species of eagle.

Table B-3. Special status wildlife species for offered lands under Coconino National Forest jurisdiction

Unless otherwise noted, range or habitat information is from the following sources: Arizona Heritage Data Management System (Arizona Game and Fish Department 2018a); USFWS Arizona Ecological Services Field Office (U.S. Fish and Wildlife Service 2016b); Tonto National Forest Final Assessment (U.S. Forest Service 2017d); Tonto National Forest Threatened, Endangered and Sensitive Species Abstracts (Tonto National Forest 2000); NatureServe (NatureServe 2018); Reptiles and Amphibians of Arizona (Brennan 2008); eBird (2018)

Common Name (*Scientific Name*)	**Status***	**HDMS Records within 2 miles**	**Baseline Data Records**	**Other Records (eBird, SWCA, or Forest Service Site Visits, Reptiles of Arizona)**	**Habitat Components (Elevation, Soils, Vegetation Association, Slope, Aspect, etc.)**	**Geographical Range in Arizona**	**Likelihood of Occurrence in Offered Lands**
Amphibians							
Arizona toad (*Anaxyrus microscaphus*)	CNF: S	Yes	No	Reptiles of Arizona	Species prefers rocky stream and canyons in pine-oak associations and in lower deserts. Elevation ranges from sea level to 8,000 feet above mean sea level (amsl)	Found in canyons and floodplains south of the Mogollon Rim	Known to occur: East Clear Creek
Chiricahua leopard frog (*Lithobates chiricahuensis*)	ESA: T (All Arizona counties except La Paz, Mohave, Pinal, Yuma)	Yes	No	No	Species is known from mid-elevation wetland communities such as tanks, lakes, reservoirs, streams, and rivers; often surrounded by an arid environment. Elevational range of 3,281–8,890 feet amsl.	Species occurs along the Mogollon Rim and in mountainous areas of southeastern Arizona	Known to occur: East Clear Creek
Northern leopard frog (*Lithobates pipiens*)	CNF: S	Yes	No	Reptiles of Arizona	Range of habitats that includes grasslands, brush land, and forests, usually in permanent water; elevational range of 2,640–9,155 feet amsl	Found in northern and central Arizona	Known to occur: East Clear Creek
Lowland leopard frog (*Lithobates yavapaiensis*)	CNF: S	No	No	No	Aquatic systems in elevations ranging from 480–6,200 feet amsl; species is found using a variety of habitats both natural and human-made	Species occurs in central and southeastern Arizona	Unlikely to occur
Birds							
Northern goshawk (*Accipiter gentilis*)	CNF: S	Yes	Yes (WestLand Resources Inc. 2017c)	eBird	Species is found in wide variety of forest associations including deciduous, coniferous and mixed forests; prefers mature forests for breeding in elevations ranging from 4,750–9,120 feet amsl	Species is found statewide in tall, forested mountains	Known to occur: East Clear Creek
Clark's grebe (*Aechmophorus clarkii*)	CNF: S	No	No	No	Requires large, deep bodies of water for fishing	Species is present on large reservoirs and along the Colorado River	Unlikely to occur
Golden eagle (*Aquila chrysaetos*)	BGEPA: Yes	No	No	No	Species prefers mountainous areas, nesting occurs at elevations between 4,000–10,000 feet amsl	Species is found throughout Arizona	Possible to occur: East Clear Creek
Western burrowing owl (*Athene cunicularia hypugaea*)	CNF: S	No	No	No	Species is found in open, dry grasslands, deserts, and agricultural lands; elevation ranges from 650–6,140 feet amsl	Species is found in southern Arizona and in agricultural areas in Maricopa and Pinal Counties	Unlikely to occur
Ferruginous hawk (*Buteo regalis*)	CNF: S	No	No	No	Species is found in open grasslands, scrublands, and woodlands in winter; ranges in elevation from 3,500 to 6,000 feet amsl	Species is found throughout the state in winter, breeds on Colorado Plateau	Unlikely to occur
Common black hawk (*Buteogallus anthracinus*)	CNF: S	Yes	No	eBird	Species only present during breeding season; riparian obligate found along streams between 1,750–7,080 feet amsl	Breeding range is along streams draining the Mogollon Rim; species can be found throughout the state during migration	Known to occur: East Clear Creek
Western yellow-billed cuckoo (DPS) (*Coccyzus americanus occidentalis*)	ESA: T (all Arizona counties) CNF: S	No	No	No	Typically found in riparian woodland vegetation—cottonwood (*Populus* spp.), willow (*Salix* spp.), or saltcedar (*Tamarix* spp.)—at elevations below 6,600 feet amsl. Dense understory foliage appears to be an important factor in nest site selection.	Species occurs at its highest concentrations in Arizona are along the Agua Fria, San Pedro, upper Santa Cruz, and Verde River drainages and Cienega and Sonoita Creeks.	Unlikely to occur
Southwestern willow flycatcher (*Empidonax traillii extimus*)	ESA: E (all Arizona counties except Navajo County)	No	No	No	Found in dense riparian habitats along streams, rivers, and other wetlands where cottonwood (*Populus* spp.), willow (*Salix* spp.), boxelder (*Acer negundo*), saltcedar (*Tamarix* spp.), Russian olive (*Elaeagnus angustifolia*), buttonbush (*Cephalanthus* spp.), and arrowweed (*Pluchea sericea*) are present. Nests are found in thickets of trees and shrubs, primarily those that are 13 to 23 feet tall, among dense, homogeneous foliage. Habitat occurs at elevations below 8,500 feet amsl.	Species breeds very locally along the middle Gila, Salt, Verde, middle to lower San Pedro, and upper San Francisco Rivers; also, locally around Colorado River near the mouth of the Little Colorado River, the headwaters of the Little Colorado and locations south of Yuma; species can be found in a variety of habitat types during migration	Unlikely to occur

Common Name (*Scientific Name*)	Status*	HDMS Records within 2 miles	Baseline Data Records	Other Records (eBird, SWCA, or Forest Service Site Visits, Reptiles of Arizona)	Habitat Components (Elevation, Soils, Vegetation Association, Slope, Aspect, etc.)	Geographical Range in Arizona	Likelihood of Occurrence in Offered Lands
American peregrine falcon (*Falco peregrinus anatum*)	CNF: S	Yes	(WestLand Resources Inc. 2017c)	No	Species is found near cliffs overlooking habitats that support large numbers of birds; range in elevations from 400–9,000 feet amsl	Species breeds throughout state only on cliffs near abundant prey items	Known to occur: East Clear Creek
California condor (*Gymnogyps californianus*)	ESA: ENE (Apache, Coconino, Mohave, Navajo and Yavapai Counties)	No	No	No	Roosts and nest in steep terrain with rock outcroppings, cliffs, and caves. High perches are necessary to create the strong updrafts the bird requires to lift into flight, and open grasslands or savannahs are essential for searching for food	Occurs mostly along the Grand Canyon and Kaibab Plateau in northern Arizona	Unlikely to occur
Bald eagle (*Haliaeetus leucocephalus*)	CNF: S BGEPA: Yes	Yes	(WestLand Resources Inc. 2017c)	eBird	Habitat components include large bodies of water with lots of coastline and tall perches above water to allow for hunting	Found throughout much of the central and northern parts of Arizona, near large bodies of water	Known to occur: East Clear Creek
Abert's towhee (*Melozone aberti*)	CNF: S	No	No	No	Habitat includes woodlands and thickets usually near water, occurs in riparian woods, exotic vegetation such as salt cedar, along agricultural fields and in suburban areas	Species is found in lower elevation areas of central, southern and western Arizona	Unlikely to occur
Mexican spotted owl (*Strix occidentalis lucida*)	ESA: T (All counties except La Paz and Yuma Counties)	Yes	(WestLand Resources Inc. 2017c)	No	Found in mature montane forests and woodlands and steep, shady, wooded canyons. Can also be found in mixed-conifer and pine-oak vegetation types; generally nests in older forests of mixed conifers or ponderosa pine (*Pinus ponderosa*)–Gambel oak (*Quercus gambelii*). Nests in live trees on natural platforms (e.g., dwarf mistletoe [*Arceuthobium* spp.] brooms), snags, and canyon walls at elevations between 4,100 and 9,000 feet amsl.	Found throughout the state in summer in forested mountains with steep canyons; found in almost all counties of Arizona; recently species has been found wintering in lower riparian areas such as Tonto Creek and Sabino Canyon	Known to occur: East Clear Creek
Fish							
Longfin dace (*Agosia chrysogaster*)	CNF: S	No	No	No	Habitat varies from intermittent hot low-desert stream to clear, cool streams at higher elevations; prefers medium- to small-sized streams with sandy/gravely bottoms and pools with some cover. Species is normally found below 4,900 feet amsl.	Occurs in central, southern, and southeastern Arizona	Unlikely to occur
California floater (*Anodonta californiensis*)	CNF: S	Yes	No	No	Species prefers shallow areas, less than 2 meters deep in unpolluted lakes, reservoirs, and perennial streams with relatively stable water levels of low velocity flow regimes; elevational range of 4,000–8,670 feet amsl	Occurs in Apache and Greenlee Counties, found in the Black River part of the Gila River Basin System	Known to occur: East Clear Creek
Desert sucker (*Catostomus clarki*)	CNF: S	No	No	No	Species is found in flowing pools of streams and rivers with a gravel substrate; elevational range of 480–8,840 feet amsl	Found throughout the Gila River basin and in tributaries to the Bill Williams River	Possible to occur: East Clear Creek
Bluehead sucker (*Catostomus discobolus discobolus*)	CNF: S	No	No	No	Species occurs in a variety of habitats from small streams to large rivers ranging from cold clear streams to warm, turbid rivers; elevational range of 2,001-6,759 feet amsl	Occurs in the Colorado River mainstem and Grand Canyon tributaries	Unlikely to occur
Sonora sucker (*Catostomus insignis*)	CNF: S	No	No	No	Found in a variety of habitats from warm rivers to cool streams, prefers gravelly or rocky pools in elevations ranging from 1,210–8,730 feet amsl	Found in the Gila and Bill Williams river basins	Possible to occur: East Clear Creek
Little Colorado sucker (*Catostomus* sp.)	CNF: S	Yes	(WestLand Resources Inc. 2017c)	No	Species prefers creeks, small to medium rivers and impoundments most often with abundant cover; elevational range of 2,200–7,100 feet amsl	Species is endemic to the upper portion of the Little Colorado River and some of its north-flowing tributaries	Known to occur: East Clear Creek
Gila chub (*Gila intermedia*)	ESA: E (Cochise, Coconino, Gila, Graham, Greenlee, Pima, Pinal, Santa Cruz, and Yavapai Counties)	No	No	No	Normally found in smaller headwater streams, cienegas, and springs or marshes of the Gila River Basin at elevations below 2,720 and 5,420 feet amsl.	Currently found in the following drainages: Santa Cruz River, Middle Gila River, San Pedro River, Agua Fria River and Verde River	Possible to occur: East Clear Creek

Common Name (*Scientific Name*)	Status*	HDMS Records within 2 miles	Baseline Data Records	Other Records (eBird, SWCA, or Forest Service Site Visits, Reptiles of Arizona)	Habitat Components (Elevation, Soils, Vegetation Association, Slope, Aspect, etc.)	Geographical Range in Arizona	Likelihood of Occurrence in Offered Lands
Headwater chub (*Gila nigra*)	CNF: S	No	No	No	Species is found in the middle to headwater reaches of medium-sized streams with large pools and cover; elevational range of 925–2,000 feet amsl	Current range includes streams in the Verde River basin, Tonto Creek subbasin and San Carlos River basin in Yavapai, Gila and Graham Counties	Unlikely to occur
Roundtail chub (*Gila robusta*)	CNF: S	No	(WestLand Resources Inc. 2017c)	No	Species prefers cool to warm water in mid-elevation streams and rivers with pools up to 6.6 feet deep near flowing water. Cover consists of boulders, tree roots, deep water and submerged vegetation. Elevational range of 1,210–7,220 feet amsl.	Occurs in tributaries to the Little Colorado River, tributaries to the Bill Williams River basin, the Salt River and its tributaries, the Verde River and its tributaries, Aravaipa Creek and Eagle Creek	Known to occur: East Clear Creek
Little Colorado spinedace (*Lepidomeda vittata*)	ESA: T (Apache, Coconino, and Navajo Counties)	Yes	(WestLand Resources Inc. 2017c)	No	Habitat consists of medium to small streams and is characteristically found in pools with water flowing over fine gravel and silt-mud substrates; elevational range of 4,000–8,000 feet amsl	Found in East Clear Creek and its tributaries, Chevelon and Silver Creeks, and Nutrioso Creek and the Little Colorado River	Known to occur: East Clear Creek
Spikedace (*Meda fulgida*)	ESA: E (Apache, Cochise, Coconino, Gila, Graham, Greenlee, Maricopa, Pinal, and Yavapai Counties)	No	No	No	Found in medium-sized to large perennial streams, where it inhabits moderate-velocity to fast waters over gravel and rubble substrates, typically at elevations below 6,000 feet amsl	In Arizona, populations are found in the middle Gila, and Verde Rivers and Aravaipa and Eagle Creeks.	Unlikely to occur
Gila trout (*Oncorhynchus gilae gilae*)	ESA: T (Apache, Coconino, Gila, Graham, Greenlee, Navajo, and Yavapai Counties)	No	No	No	Species is found in small mountain headwater streams, which are generally narrow and shallow, and rarely exceed 70 degrees Fahrenheit. Siltation is usually low and cobble is the predominant substrate; Elevational range of 5,446-9,220 feet amsl.	Historically found in Verde and Agua Fria drainages. Species has been introduced to Gap Creek and Dude Creek, but those populations are in jeopardy or have been extirpated. Species could still be present in tributaries to the Verde River such as Oak Creek and West Clear Creek.	Unlikely to occur
Gila topminnow (*Poeciliopsis occidentalis occidentalis*)	ESA: E (Cochise, Gila, Graham, Maricopa, Pima, Pinal, Santa Cruz, and Yavapai Counties)	No	No	No	Occurs in small streams, springs, and cienegas at elevations below 4,500 feet amsl, primarily in shallow areas with aquatic vegetation and debris for cover	In Arizona, most of the remaining native populations are in the Santa Cruz River system.	Unlikely to occur
Colorado pikeminnow (*Ptychocheilus lucius*)	ESA: E, ENE (Gila, Maricopa, and Yavapai Counties)	No	No	No	Juveniles prefer slackwater, backwater and side channels with little or no flow and silty substrates; adults utilize turbid, deep and fast flowing waters. Species was reintroduced at an elevation of 1,960 feet amsl.	Considered extirpated from the state, two experimental populations have been stocked into Salt and Verde River drainages	Unlikely to occur
Loach minnow (*Tiaroga cobitis*)	ESA: E (Apache, Cochise, Coconino, Gila, Graham, Greenlee, Pinal, and Yavapai Counties)	No	No	No	Found in small to large perennial creeks and rivers, typically in shallow, turbulent riffles with cobble substrate, swift currents, and filamentous algae at elevations below 8,000 feet amsl	Its range in Arizona is limited to reaches in the East Fork of the White River (Navajo County); Aravaipa, Deer, and Turkey Creeks (Graham and Pinal Counties); San Francisco and Blue Rivers; and Eagle, Campbell Blue, and Little Blue Creeks (Greenlee County). A population was discovered in the Black River in 1996.	Unlikely to occur
Razorback sucker (*Xyrauchen texanus*)	ESA: E (Coconino, Gila, Graham, Greenlee, La Paz, Maricopa, Mohave, Pinal, Yavapai, and Yuma Counties)	No	No	No	Found in backwaters, flooded bottomlands, pools, side channels, and other slower-moving habitats at elevations below 6,000 feet amsl	In Arizona, populations are restricted to Lakes Mohave and Mead and the lower Colorado River below Havasu in the Lower Basin. In the Upper Basin, small remnant populations are found in the Green, Yampa, and main stem Colorado Rivers.	Unlikely to occur
Invertebrates							
A mayfly (*Homoleptohyphes quercus*)	CNF: S	No	No	No	Habitat is primarily lotic depositional, some lentic littoral. Larvae are common in flowing waters ranging from small streams to large rivers, but they occur in areas of slow current. Preferred substrates include silt, fine sand, gravel, woody debris, moss and other plant growth on stones, exposed roots of terrestrial plants, and at the base of rooted aquatic vegetation.	Occurs in Coconino and Pinal Counties	Possible to occur: East Clear Creek

Common Name (*Scientific Name*)	Status*	HDMS Records within 2 miles	Baseline Data Records	Other Records (eBird, SWCA, or Forest Service Site Visits, Reptiles of Arizona)	Habitat Components (Elevation, Soils, Vegetation Association, Slope, Aspect, etc.)	Geographical Range in Arizona	Likelihood of Occurrence in Offered Lands
Four-spotted skipperling (*Piruna polingii*)	CNF: S	No	No	No	Habitat includes moist woodland openings with lush vegetation, meadows, ravines and streamsides in the mountains	Occurs from central Arizona south to Mexico	Possible to occur: East Clear Creek
Page springsnail (*Pyrgulopsis morrisoni*)	CNF: S	No	No	No	Occurs on firm substrates such as rocks, vegetation, floating algal mats and submerged woody debris in association with slow to moderate flows of head springs, seeps and lateral runs; elevational range of 3,300–3,600 feet amsl	Occurs in several springs along Oak Creek in the Bubbling Springs complex, the Page Springs complex, and on private land in the Verde Valley	Unlikely to occur
Fossil springsnail (*Pyrgulopsis simplex*)	CNF: S	No	No	No	Habitat is only present at headsprings and upper section of the outflow, generally found on rocks or aquatic macrophytes in moderate current	Occurs in Gila and Yavapai Counties, Arizona	Unlikely to occur
Nitocris fritillary (*Speyeria nokomis nitocris*)	CNF: S	No	No	No	Occurs in alpine meadows, the species' host plant is *Viola nephrophylla*	Occurs in eastern Arizona	Unlikely to occur
Nokomis fritillary (*Speyeria nokomis nokomis*)	CNF: S	No	No	No	Occurs in streamside meadows and open seepage areas with an abundance of violets in generally desert landscapes	Occurs in eastern Arizona	Unlikely to occur
Mammals							
Mexican gray wolf (*Canis lupus baileyi*)	ESA: E (Apache and Greenlee Counties)	No	No	No	Vegetation type not important, species mostly needs sufficient prey such as deer and elk. Reintroduction areas are typically rugged lands in coniferous forest. Elevational range of 3,000–12,000 feet amsl	Occurs in Apache and Greenlee Counties, reintroductions are occurring in Apache County. All packs are currently located on the Apache-Sitgreaves National Forest (AGFD 2018a).	Unlikely to occur
Pale Townsend's big-eared bat (*Corynorhinus townsendii pallescens*)	CNF: S	No	No	No	In summer the species is found in caves and mines in elevations ranging from 550–7,520 feet amsl; in winter the species is found in cold caves, lava tubes, and mines in higher elevations than summer	Widespread, documented in almost all counties	Possible to occur: East Clear Creek
Spotted bat (*Euderma maculatum*)	CNF: S	No	No	No	Habitat can vary widely from dry deserts to conifer forest, prefer to roost in crevices and cracks in cliff faces; elevational range of 110–8,670 feet amsl	Not well known, records from Yuma County, Maricopa County, Kaibab Plateau and some heard only records from eastern Arizona	Possible to occur: East Clear Creek
Greater western mastiff bat (*Eumops perotis californicus*)	CNF: S	No	No	No	Species prefers lower and upper Sonoran desertscrub near cliffs with lots of crevices; elevational range of 240–8,475 feet amsl	Year-round and widespread in the state	Possible to occur: East Clear Creek
Allen's lappet-browed or big-eared bat (*Idionycteris phyllotis*)	CNF: S	No	No	No	Found in ponderosa pine, pinyon-juniper, Mexican woodland and riparian areas with cottonwoods, sycamores and willows, also have records from desertscrub and white fir habitats; elevational range of 1,320–9,800 feet amsl	Widespread in Arizona except for deserts in southwestern Arizona, most records from southern Colorado Plateau, Mogollon Rim and adjacent mountain ranges	Possible to occur: East Clear Creek
Western red bat (*Lasiurus blossevillii*)	CNF: S	No	No	No	Habitat consists of riparian and wooded areas, typically roosts in cottonwood trees; elevational range of 1,900–7,200 feet amsl	South-central to southern and southeastern Arizona, summer resident only; historic records from Sierra Ancha Mountains and Queen Creek	Possible to occur: East Clear Creek
Long-tailed vole (*Microtus longicaudus*)	CNF: S	No	No	No	Occurs in various habitats ranging from dense coniferous forests to rocky alpine tundra, sagebrush semidesert, moist meadows, marshes, and forest-edge habitat; elevational range of sea level to 11,975 feet amsl	Found in northern and central Arizona	Unlikely to occur
Navajo Mogollon vole (*Microtus mogollonensis navaho*)	CNF: S	No	No	No	Species prefers clear-cut pine flat that is growing back as grassland with scattered oaks, rocky slopes with open uncut ponderosa forest with openings, and pinyon juniper with scattered ponderosa pine stands	Occurs in Apache and Coconino Counties, in the Little Colorado headwaters, Canyon Diablo, Lower Little Colorado, and Upper Verde watersheds	Unlikely to occur

Common Name (*Scientific Name*)	Status*	HDMS Records within 2 miles	Baseline Data Records	Other Records (eBird, SWCA, or Forest Service Site Visits, Reptiles of Arizona)	Habitat Components (Elevation, Soils, Vegetation Association, Slope, Aspect, etc.)	Geographical Range in Arizona	Likelihood of Occurrence in Offered Lands
Black-footed ferret (*Mustela nigripes*)	ESA: ENE (Coconino and Yavapai Counties)	No	No	No	Occurs in arid prairies, characterized as Plains and Great Basin Grassland community; elevational range of 5,250–6,234 feet amsl	Species is reintroduced into the Aubrey Valley in Coconino County	Unlikely to occur
Wupatki Arizona pocket mouse (*Perognathus amplus cineris*)	CNF: S	No	No	No	Found in various types of desert scrub habitats and in some scrub oak habitats; elevational range of 3,900–5,420 feet amsl	Found only from Echo Cliffs in the north, south and east to the Colorado River and to the Little Colorado River, south of Wupatki National Monument	Unlikely to occur
Plains harvest mouse (*Reithrodontomys montanus*)	CNF: S	No	No	No	Occurs in well-developed grasslands in areas with less than 50 percent bare soil; elevational range of 275–6,300 feet amsl	Species occurs in southeastern Arizona	Unlikely to occur
Merriam's shrew (*Sorex merriami leucogenys*)	CNF: S	No	No	No	Sagebrush steppe	Northeastern Arizona	Unlikely to occur
Dwarf shrew (*Sorex nanus*)	CNF: S	No	No	No	Occupies numerous habitats including rocky areas in alpine tundra and partly into subalpine coniferous forest, other types of rocky slopes, sedge marsh, subalpine meadow, dry brushy slopes, arid shortgrass prairie, dry stubble fields, and pinyon-juniper woodland	Occurs along the Kaibab Plateau, San Francisco Peaks, and White Mountains	Unlikely to occur
Reptiles							
Reticulate Gila monster (*Heloderma suspectum suspectum*)	CNF: S	No	No	No	Occurs in Sonoran Desert and extreme western edge of Mohave Desert, less frequent in desert-grassland and rare in oak woodland; most common in undulating rocky foothills, bajadas, and canyons	Occurs in the western and southwestern portion of the state	Unlikely to occur
Northern Mexican gartersnake (*Thamnophis eques megalops*)	ESA: T (All counties except Maricopa and Yuma Counties) CNF: S	No	No	No	Species prefers cienegas, streams, and rivers in habitats ranging from upland Sonoran desertscrub to montane coniferous forests; elevational range of 1,000–6,700 feet amsl	Species is found along the Mogollon Rim and a few isolated populations in south-central Arizona	Unlikely to occur
Narrow-headed gartersnake (*Thamnophis rufipunctatus*)	ESA: T (Apache, Coconino, Gila, Graham, Greenlee, Navajo, and Yavapai Counties) CNF: S	No	No	No	Species prefers pinyon-juniper and pine-oak woodlands, ranging into ponderosa pine at elevations between 2,440–8,080 feet amsl; species needs permanent water source	Species is found along the Mogollon Rim	Unlikely to occur

* Status Definitions

Endangered Species Act (ESA):

E = Endangered. Endangered species are those in imminent jeopardy of extinction. The ESA specifically prohibits the take of a species listed as endangered. Take is defined by the ESA as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to engage in any such conduct.

T = Threatened. Threatened species are those that are likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

ENE = Reintroduced populations designated as Experimental – Nonessential, under ESA.

Coconino National Forest (CNF):

S = Sensitive. Species identified by a Regional Forester for which population viability is a concern, as evidenced by: a. significant current or predicted downward trends in population number or density. B. Significant current or predicted downward trends in habitat capability that would reduce a species' existing distribution.

Bald and Golden Eagle Protection Act (BGEPA):

Yes = A species protected by a United States Federal statute that protects two species of eagle.

Table B-4. Special status wildlife species for offered lands under BLM jurisdiction

Unless otherwise noted, range or habitat information is from the following sources: Arizona Heritage Data Management System (Arizona Game and Fish Department 2018a); USFWS Arizona Ecological Services Field Office (U.S. Fish and Wildlife Service 2016b); Tonto National Forest Threatened, Endangered and Sensitive Species Abstracts (Tonto National Forest 2000); NatureServe (NatureServe 2018); Reptiles of Arizona (Brennan 2008); eBird (2018)

Common Name (*Scientific Name*)	Status*	HDMS Records within 2 miles	Baseline Data Records	Other Occurrence Records (eBird, SWCA or BLM Site Visits, Reptiles of Arizona)	Habitat Components (Elevation, Soils, Vegetation Association, Slope, Aspect, etc.)	Geographical Range in Arizona	Likelihood of Occurrence in BLM Offered Lands
Amphibians							
Arizona toad (*Anaxyrus microscaphus*)	BLM: S	No	No	No	Species prefers rocky stream and canyons in pine-oak associations and in lower deserts; elevational range from sea level to 8,000 feet amsl	Found in canyons and floodplains south of the Mogollon Rim	Possible to occur: Dripping Springs
Sonoran green toad (*Anaxyrus retiformis*)	BLM: S	No	No	No	Species is found in rain pools, wash bottoms, and areas near water in semi-arid mesquite-grassland, creosote desert and upland saguaro-paloverde desert; elevational range of 500–3,225 feet amsl	Found in south-central Arizona, from Organ Pipe Cactus National Monument to 9 miles north of Pima/Pinal county line in Santa Rosa Valley	Unlikely to occur
Great Plains narrow-mouthed toad (*Gastrophryne olivacea*)	BLM: S	No	No	No	Found in mesquite semi-desert grassland to oak woodland near streams, springs, and rain pools; elevational range of sea level to 4,100 feet amsl	Found from Santa Cruz County north to Maricopa County and west to near Ajo, in Pima County	Unlikely to occur
Plains leopard frog (*Lithobates blairi*)	BLM: S	No	No	No	Found near stream, ponds, reservoirs, marshes, or irrigation ditches in prairies and desert grasslands; elevational range of 4,060–5,880 feet amsl	Isolated population located on the western side of the Chiricahua Mountains, Cochise County, Arizona	Unlikely to occur
Chiricahua leopard frog (*Lithobates chiricahuensis*)	ESA: T (All Arizona counties except La Paz, Mohave, Pinal, Yuma) BLM: S	Yes, Appleton Ranch	No	Reptiles of Arizona	Species is known from mid-elevation wetland communities such as tanks, lakes, reservoirs, streams, and rivers; often surrounded by an arid environment. Elevational range of 3,281–8,890 feet amsl.	Species occurs along the Mogollon Rim and in mountainous areas of southeastern Arizona	Possible to occur: Appleton Ranch
Northern leopard frog (*Lithobates pipiens*)	BLM: S	No	No	No	Range of habitats that includes grasslands, brush land, and forests, usually in permanent water; elevational range of 2,640–9,155 feet amsl	Found in northern and central Arizona	Unlikely to occur
Lowland leopard frog (*Lithobates yavapaiensis*)	BLM: S	Yes, Dripping Springs, Lower San Pedro River	No	Reptiles of Arizona	Aquatic systems in elevations ranging from 480–6,200 feet amsl; species is found using a variety of habitats both natural and human-made	Species occurs in central and southeastern Arizona	Known to occur: Lower San Pedro River, Dripping Springs; possible site: Appleton Ranch
Birds							
Northern goshawk (*Accipiter gentilis*)	BLM: S	No	No	No	Species is found in wide variety of forest associations including deciduous, coniferous, and mixed forests; prefers mature forests for breeding in elevations ranging from 4,750–9120 feet amsl	Species is found statewide in tall, forested mountains	Unlikely to occur
Arizona grasshopper sparrow (*Ammodramus savannarum ammolegus*)	BLM: S	Yes, Appleton Ranch, Dripping Springs	No	eBird: Appleton Ranch, Dripping Springs, Lower San Pedro River	Species preferred habitat is open grasslands with some shrubs between 3,800–5,300 feet amsl	Species is found in southern Arizona year-round	Known to occur: Appleton Ranch, Dripping Springs, Lower San Pedro River
Golden eagle (*Aquila chrysaetos*)	BLM: S BGEPA: Yes	Yes, Appleton Ranch, Dripping Springs, Lower San Pedro River	No	eBird: Appleton Ranch, Dripping Springs, Lower San Pedro River	Species prefers mountainous areas, nesting occurs at elevations between 4,000–10,000 feet amsl	Species is found throughout Arizona	Known to occur: Appleton Ranch, Dripping Springs, Lower San Pedro River
Western burrowing owl (*Athene cunicularia hypugaea*)	BLM: S	Yes, Appleton Ranch	No	eBird: Appleton Ranch	Species is found in open, dry grasslands, deserts, and agricultural lands; elevation ranges from 650–6,140 feet amsl	Species is found in southern Arizona and in agricultural areas in Maricopa and Pinal Counties	Known to occur: Appleton Ranch
Ferruginous hawk (*Buteo regalis*)	BLM: S	Yes, Appleton Ranch, Dripping Springs, Lower San Pedro River	No	eBird: Appleton Ranch, Dripping Springs, Lower San Pedro River	Species is found in open grasslands, scrublands, and woodlands in winter; ranges in elevation from 3,500 to 6,000 feet amsl	Species is found throughout the state in winter, breeds on Colorado Plateau	Known to occur: Appleton Ranch, Dripping Springs, Lower San Pedro River

Common Name (*Scientific Name*)	**Status***	**HDMS Records within 2 miles**	**Baseline Data Records**	**Other Occurrence Records (eBird, SWCA or BLM Site Visits, Reptiles of Arizona)**	**Habitat Components (Elevation, Soils, Vegetation Association, Slope, Aspect, etc.)**	**Geographical Range in Arizona**	**Likelihood of Occurrence in BLM Offered Lands**
Western yellow-billed cuckoo (DPS) (*Coccyzus americanus*)	ESA: T (all Arizona counties) BLM: S	Yes, Appleton Ranch, Lower San Pedro River	Yes, Lower San Pedro River (Wilbor 2010)	eBird: Appleton Ranch, Lower San Pedro River	Typically found in riparian woodland vegetation (cottonwood, willow, or saltcedar) at elevations below 6,600 feet amsl. Dense understory foliage appears to be an important factor in nest site selection.	Species occurs at its highest concentrations in Arizona along the Agua Fria, San Pedro, upper Santa Cruz, and Verde River drainages and in Cienega and Sonoita Creeks.	Known to occur: Appleton Ranch, Lower San Pedro River
Gilded flicker (*Colaptes chrysoides*)	BLM: S	Yes, Dripping Springs, Lower San Pedro River	No	eBird: Appleton Ranch, Lower San Pedro River	Habitat includes stands of large saguaros, Joshua trees, and low-elevation riparian groves	Species is restricted to the Sonoran Desert	Known to occur: Appleton Ranch, Lower San Pedro River; possible site: Dripping Springs
Southwestern willow flycatcher (*Empidonax traillii extimus*)	ESA: E (all Arizona counties except Navajo County) BLM: S	Yes, Appleton Ranch, Dripping Springs, Lower San Pedro River	No	eBird: Lower San Pedro River	Found in dense riparian habitats along streams, rivers, and other wetlands where cottonwood (*Populus* spp.), willow (*Salix* spp.), boxelder (*Acer negundo*), saltcedar (*Tamarix* spp.), Russian olive (*Elaeagnus angustifolia*), buttonbush (*Cephalanthus* spp.), and arrowweed (*Pluchea sericea*) are present. Nests are found in thickets of trees and shrubs, primarily those that are 13 to 23 feet tall, among dense, homogeneous foliage. Habitat occurs at elevations below 8,500 feet amsl.	Species breeds very locally along the middle Gila, Salt, Verde, middle to lower San Pedro, and upper San Francisco Rivers; also, locally around Colorado River near the mouth of the Little Colorado River, the headwaters of the Little Colorado and locations south of Yuma; species can be found in a variety of habitat types during migration	Possible to occur: Lower San Pedro River
American peregrine falcon (*Falco peregrinus anatum*)	BLM: S	Yes, Appleton Ranch, Dripping Springs, Lower San Pedro River	No	eBird: Appleton Ranch	Species is found near cliffs overlooking habitats that support large numbers of birds; range in elevations from 400–9,000 feet amsl	Species breeds throughout state only on cliffs near abundant prey items	Known to occur: Appleton Ranch; possible sites: Lower San Pedro River, Dripping Springs
Cactus ferruginous pygmy-owl (*Glaucidium brasilianum cactorum*)	BLM: S	No	No	No	Species prefers streamside cottonwoods and willows near mesquite bosques; can also be found in dry washes with large mesquite, paloverde, ironwood, and saguaro	Occurs in Organ Pipe Cactus National Monument and suburban Tucson	Possible to occur: Lower San Pedro River
California condor (*Gymnogyps californianus*)	ESA: ENE (Apache, Coconino, Mohave, Navajo and Yavapai Counties) BLM: S	No	No	No	Roosts and nest in steep terrain with rock outcroppings, cliffs, and caves. High perches are necessary to create the strong updrafts the bird requires to lift into flight, and open grasslands or savannahs are essential for searching for food	Occurs mostly along the Grand Canyon and Kaibab Plateau in northern Arizona	Unlikely to occur
Pinyon jay (*Gymnorhinus cyanocephalus*)	BLM: S	No	No	No	Habitat consists of pinyon-juniper woodland, sometimes found in pine forests and in scrub oak or sagebrush areas	Species is found along and above the Mogollon Rim in northern Arizona	Possible to occur: Dripping Springs
Bald eagle (*Haliaeetus leucocephalus*)	BLM: S BGEPA: Yes	Yes, Appleton Ranch, Dripping Springs, Lower San Pedro River	No	No	Habitat components include large bodies of water with lots of coastline and tall perches above water to allow for hunting	Found throughout much of the central and northern parts of Arizona, near large bodies of water	Unlikely to occur
California black rail (*Laterallus jamaicensis coturniculus*)	BLM: S	No	No	No	Habitat in Arizona consists of shallow water habitat with emergent and shoreline vegetation. Prefers areas where water levels do not fluctuate.	Occurs only in southwestern part of state along the Colorado River in Yuma County	Unlikely to occur
Arizona Botteri's sparrow (*Peucaea botterii arizonae*)	BLM: S	Yes, Appleton Ranch	No	eBird: Appleton Ranch	Species is found in grasslands with scattered mesquite trees	Occurs in southeastern Arizona	Known to occur: Appleton Ranch
Desert purple martin (*Progne subis hesperia*)	BLM: S	Yes, Dripping Springs, Lower San Pedro River	No	eBird: Lower San Pedro River	Habitat consists of Sonoran Desert with many large saguaros proximal to water	Species is found in southern and central Arizona	Known to occur: Lower San Pedro River; possible site: Dripping Springs
Yuma Ridgeway's rail (*Rallus longirostris yumanensis*)	ESA: E (Gila, La Paz, Maricopa, Mohave, Pinal, and Yuma Counties) BLM: S	No	No	No	In Arizona, found at elevations below 4,500 feet amsl in freshwater marshes, which are often dominated by cattails (*Typha* spp.), bulrushes (*Isolepis* spp.), and sedges (*Carex* spp.).	Range includes the Colorado River from Lake Mead to Mexico; the Gila and Salt Rivers upstream to the area of the Verde confluence; Picacho Reservoir; and the Tonto Creek arm of Roosevelt Lake. This species may be expanding into other suitable marsh habitats in western and central Arizona.	Unlikely to occur
California least tern (*Sternula antillarum browni*)	BLM: S	No	No	No	Habitat includes seacoasts, beaches, bays, estuaries, lagoons, lakes, and rivers	Species is rarely found in the state, one breeding record occurred in 2009 in Maricopa County but the species has not bred in the state since.	Unlikely to occur

Common Name (*Scientific Name*)	Status*	HDMS Records within 2 miles	Baseline Data Records	Other Occurrence Records (eBird, SWCA or BLM Site Visits, Reptiles of Arizona)	Habitat Components (Elevation, Soils, Vegetation Association, Slope, Aspect, etc.)	Geographical Range in Arizona	Likelihood of Occurrence in BLM Offered Lands
Mexican spotted owl (*Strix occidentalis lucida*)	ESA: T (All counties except La Paz and Yuma Counties) BLM: S	Yes, Appleton Ranch	No	No	Found in mature montane forests and woodlands and steep, shady, wooded canyons. Can also be found in mixed-conifer and pine-oak vegetation types; generally nests in older forests of mixed conifers or ponderosa pine (*Pinus ponderosa*)–Gambel oak (*Quercus gambelii*). Nests in live trees on natural platforms (e.g., dwarf mistletoe [*Arceuthobium* spp.] brooms), snags, and canyon walls at elevations between 4,100 and 9,000 feet amsl.	Found throughout the state in summer in forested mountains with steep canyons; found in almost all counties of Arizona; recently species has been found wintering in lower riparian areas such as Tonto Creek and Sabino Canyon	Unlikely to occur
Le Conte's thrasher (*Toxostoma lecontei*)	BLM: S	Yes, Dripping Springs	No	No	Flat, open saltbush deserts with a few scattered mesquites or creosote present	Species is found in the low deserts of southwestern Arizona	Unlikely to occur
Fish							
Gila longfin dace (*Agosia chrysogaster*)	BLM: S	Yes, Appleton Ranch, Lower San Pedro River	No	No	Habitat varies from intermittent hot low-desert stream to clear, cool streams at higher elevations; prefers medium- to small-sized streams with sandy/gravely bottoms and pools with some cover. Species is normally found below 4,900 feet amsl.	Occurs in central, southern, and southeastern Arizona	Possible to occur: Appleton Ranch, Lower San Pedro River
Desert sucker (*Catostomus clarki*)	BLM: S	Yes, Appleton Ranch	No	No	Species is found in flowing pools of streams and rivers with a gravel substrate; elevational range of 480–8,840 feet amsl	Found throughout the Gila River basin and in tributaries to the Bill Williams River	Possible to occur: Appleton Ranch, Lower San Pedro River
Sonora sucker (*Catostomus insignis*)	BLM: S	Yes, Appleton Ranch	No	No	Found in a variety of habitats from warm rivers to cool streams, prefers gravelly or rocky pools in elevations ranging from 1,210–8,730 feet amsl	Found in the Gila and Bill Williams river basins	Possible to occur: Appleton Ranch, Lower San Pedro River
Desert pupfish (*Cyprinodon macularius*)	ESA: E (Cochise, Gila, Graham, Maricopa, Pima, Santa Cruz, and Yavapai Counties) BLM: S	Yes, Appleton Ranch	Yes, Appleton Ranch (WestLand Resources Inc. 2004b)	No	Found in shallow waters of springs, marshes and small streams, prefers soft substrates and clear water; elevational range of 1,200–3,450 feet amsl	No natural populations remaining; populations were reintroduced at sites in Graham, Yavapai, and Santa Cruz Counties	Unlikely to occur
Gila chub (*Gila intermedia*)	ESA: E (Cochise, Coconino, Gila, Graham, Greenlee, Pima, Pinal, Santa Cruz, and Yavapai Counties) BLM: S	Yes, Appleton Ranch, Dripping Springs, Lower San Pedro River	No	No	Normally found in smaller headwater streams, cienegas, and springs or marshes of the Gila River Basin at elevations below 2,720 and 5,420 feet amsl	Currently found in the following drainages: Santa Cruz River, Middle Gila River, San Pedro River, Agua Fria River, and Verde River	Possible to occur: Appleton Ranch, Lower San Pedro River
Headwater chub (*Gila nigra*)	BLM: S	No	No	No	Species is found in the middle to headwater reaches of medium-sized streams with large pools and cover; elevational range of 925–2,000 feet amsl	Current range includes streams in the Verde River basin, Tonto Creek subbasin and San Carlos River basin in Yavapai, Gila, and Graham Counties	Unlikely to occur
Roundtail chub (*Gila robusta*)	BLM: S	No	No	No	Species prefers cool to warm water in mid-elevation streams and rivers with pools up to 6.6 feet deep near flowing water. Cover consists of boulders, tree roots, deep water and submerged vegetation. Elevational range of 1,210–7,220 feet amsl.	Occurs in tributaries to the Little Colorado River, tributaries to the Bill Williams River basin, the Salt River and its tributaries, the Verde River and its tributaries, Aravaipa Creek and Eagle Creek	Possible to occur: Appleton Ranch, Lower San Pedro River
Little Colorado spinedace (*Lepidomeda vittata*)	ESA: T (Apache, Coconino and Navajo Counties) BLM: S	No	No	No	Habitat consists of medium to small streams and is characteristically found in pools with water flowing over fine gravel and silt-mud substrates; elevational range of 4,000–8,000 feet amsl	Found in East Clear Creek and its tributaries, Chevelon and Silver Creeks, and Nutrioso Creek and the Little Colorado River	Unlikely to occur
Spikedace (*Meda fulgida*)	ESA: E (Apache, Cochise, Coconino, Gila, Graham, Greenlee, Maricopa, Pinal, and Yavapai Counties) BLM: S	No	No	No	Found in medium-sized to large perennial streams, where it inhabits moderate-velocity to fast waters over gravel and rubble substrates, typically at elevations below 6,000 feet amsl	In Arizona, populations are found in the middle Gila, and Verde Rivers and Aravaipa and Eagle Creeks.	Unlikely to occur

Common Name (*Scientific Name*)	**Status***	**HDMS Records within 2 miles**	**Baseline Data Records**	**Other Occurrence Records (eBird, SWCA or BLM Site Visits, Reptiles of Arizona)**	**Habitat Components (Elevation, Soils, Vegetation Association, Slope, Aspect, etc.)**	**Geographical Range in Arizona**	**Likelihood of Occurrence in BLM Offered Lands**
Gila topminnow (incl. Yaqui) (*Poeciliopsis occidentalis*)	ESA: E (Cochise, Gila, Graham, Maricopa, Pima, Pinal, Santa Cruz, and Yavapai Counties) BLM: S	Yes, Appleton Ranch	No	No	Occurs in small streams, springs, and cienegas at elevations below 4,500 feet amsl, primarily in shallow areas with aquatic vegetation and debris for cover	In Arizona, most of the remaining native populations are in the Santa Cruz River system	Unlikely to occur
Colorado pikeminnow (*Ptychocheilus lucius*)	ESA: E, ENE (Gila, Maricopa, and Yavapai Counties)	No	No	No	Juveniles prefer slackwater, backwater and side channels with little or no flow and silty substrates; adults utilize turbid, deep and fast-flowing waters. Species was reintroduced at an elevation of 1,960 feet amsl.	Considered extirpated from the state, two experimental populations have been stocked into Salt and Verde River drainages	Unlikely to occur
Speckled dace (*Rhinichthys ocsulus*)	BLM: S	No	No	No	Species prefers rocky areas of riffles, runs, pools, creeks, and small to medium rivers	Occurs in the Colorado, Bill Williams, and Gila River drainages	Possible to occur: Lower San Pedro River
Loach minnow (*Tiaroga cobitis*)	ESA: E (Apache, Cochise, Coconino, Gila, Graham, Greenlee, Pinal, and Yavapai Counties) BLM: S	No	No	No	Found in small to large perennial creeks and rivers, typically in shallow, turbulent riffles with cobble substrate, swift currents, and filamentous algae at elevations below 8,000 feet amsl	Its range in Arizona is limited to reaches in the East Fork of the White River (Navajo County); Aravaipa, Deer, and Turkey Creeks (Graham and Pinal Counties); San Francisco and Blue Rivers; and Eagle, Campbell Blue, and Little Blue Creeks (Greenlee County). A population was discovered in the Black River in 1996.	Unlikely to occur
Razorback sucker (*Xyrauchen texanus*)	ESA: E (Coconino, Gila, Graham, Greenlee, La Paz, Maricopa, Mohave, Pinal, Yavapai, and Yuma Counties) BLM: S	No	No	No	Found in backwaters, flooded bottomlands, pools, side channels, and other slower-moving habitats at elevations below 6,000 feet amsl	In Arizona, populations are restricted to Lakes Mohave and Mead and the lower Colorado River below Havasu in the Lower Basin. In the Upper Basin, small remnant populations are found in the Green, Yampa, and main stem Colorado Rivers.	Unlikely to occur
Invertebrates							
Monarch butterfly (*Danaus plexippus* pop. 1)	BLM: S	No	No	No	Species present during spring and summer, rarely during winter at varying elevations around the state; prefers riparian habitats with milkweeds present	Species is present throughout the state	Possible to occur: Appleton Ranch, Lower San Pedro River, Dripping Springs
Bylas springsnail (*Pyrgulopsis arizonae*)	BLM: S	No	No	No	Species is found in springs ranging from 26–32 degrees Celsius with submergent vegetation	Found in three springs along the Gila River between Bylas and Pima in Graham County, Arizona	Unlikely to occur
Sonoran talussnail (*Sonorella magdalenensis*)	BLM: S	No	No	No	Species prefers talus slopes of coarse broken rock; elevational range of 2,750–6,000 feet amsl	Occurs in Pima and Santa Cruz Counties, Arizona	Unlikely to occur
Arizona cave amphipod (*Stygobromus arizonensis*)	BLM: S	No	No	No	Species prefers aquatic habitat in subterranean caves and mines; found at elevations of 5,245 feet amsl	Found only at two locations in Cochise County, Arizona	Unlikely to occur
Gila tryonia (*Tryonia gilae*)	BLM: S	No	No	No	Species is found in mildly thermal springs with submergent vegetation; elevational range of 2,600–2,800 feet amsl	Found in an unnamed spring north of Bylas, also in Cold Springs and Porter Wash in Graham County, Arizona	Unlikely to occur
Mammals							
Sonoran pronghorn (*Antilocapra americana sonoriensis*)	ESA: ENE (La Paz, Maricopa, Pima, Pinal, Santa Cruz and Yuma Counties) BLM: S	No	No	No	Found in Sonoran desertscrub within broad, intermountain, alluvial valleys with creosote (*Larrea tridentata*)–bursage (*Ambrosia* spp.) and palo verde–mixed cacti associations at elevations between 2,000 and 4,000 feet amsl	The only extant U.S. population is in southwestern Arizona	Unlikely to occur
Mexican gray wolf (*Canis lupus baileyi*)	ESA: E (Apache and Greenlee Counties) BLM: S	No	No	No	Vegetation type not important, species mostly needs sufficient prey such as deer and elk. Reintroduction areas are typically rugged lands in coniferous forest. Elevational range of 3,000–12,000 feet amsl.	Occurs in Apache and Greenlee Counties, reintroductions are occurring in Apache County. All packs are currently located on the Apache-Sitgreaves National Forests (AGFD 2018a).	Unlikely to occur

Common Name (*Scientific Name*)	Status*	HDMS Records within 2 miles	Baseline Data Records	Other Occurrence Records (eBird, SWCA or BLM Site Visits, Reptiles of Arizona)	Habitat Components (Elevation, Soils, Vegetation Association, Slope, Aspect, etc.)	Geographical Range in Arizona	Likelihood of Occurrence in BLM Offered Lands
Mexican long-tongued bat (*Choeronycteris mexicana*)	BLM: S	No	No	No	Habitat includes mesic areas in canyons of mixed oak-conifer forests in mountains rising from the desert. Roosts in daytime in caves, abandoned mines, and rockshelters; occasionally in palo verde-saguaro areas. Typically at elevations of 2,540–7,320 feet amsl.	Occurs in southeast Arizona from the Chiricahua Mountains west to the Baboquivari Mountains and as far north as the Santa Catalina Mountains. HDMS unpublished records from Pinal, Pima, Graham, Santa Cruz and Cochise Counties.	Possible to occur: Appleton Ranch
Pale Townsend's big-eared bat (*Corynorhinus townsendii*)	BLM: S	Yes, Appleton Ranch, Dripping Springs, Lower San Pedro River	No	No	In summer the species is found in caves and mines in elevations ranging from 550–7,520 feet amsl; in winter the species is found in cold caves, lava tubes, and mines in higher elevations than summer.	Occurs throughout Arizona	Possible to occur: Appleton Ranch, Lower San Pedro River, Dripping Springs
Gunnison's prairie dog (*Cynomys gunnisoni*)	BLM: S	No	No	No	Species prefers high mountain valleys and plateaus; elevational range of 6,000–12,000 feet amsl	Occurs in north-central and northeastern Arizona	Unlikely to occur
Black-tailed prairie dog (*Cynomys ludovicianus*)	BLM: S	Yes, Appleton Ranch	No	No	Habitat is dry, flat, open plains and desert grasslands; elevational range of 2,300–7,200 feet amsl	Occurs in southeast Arizona where they are reintroduced to the Las Cienegas National Conservation Area	Unlikely to occur
Banner-tailed kangaroo rat (*Dipodomys spectabilis*)	BLM: S	Yes, Appleton Ranch, Dripping Springs, Lower San Pedro River	No	No	Habitat is Great Basin desertscrub, desert grasslands with mesquite, junipers or shrubs; elevational range of 3,500–4,000 feet amsl	Occurs in Apache County	Unlikely to occur
Spotted bat (*Euderma maculatum*)	BLM: S	Yes, Appleton Ranch, Dripping Springs, Lower San Pedro River	No	No	Habitat can vary widely from dry deserts to conifer forest, prefer to roost in crevices and cracks in cliff faces; elevational range of 110–8,670 feet amsl	Not well known, records from Yuma, Roll, Maricopa County, Kaibab Plateau, and some heard-only records from eastern Arizona	Possible to occur: Appleton Ranch, Lower San Pedro River, Dripping Springs
Greater western mastiff bat (*Eumops perotis californicus*)	BLM: S	Yes, Appleton Ranch, Dripping Springs, Lower San Pedro River	No	No	Species prefers lower and upper Sonoran desertscrub near cliffs with lots of crevices; elevational range of 240–8,475 feet amsl	Occurs year-round and is widespread throughout the state	Possible to occur: Appleton Ranch, Lower San Pedro River, Dripping Springs
Allen's lappet-browed or big-eared bat (*Idionycteris phyllotis*)	BLM: S	No	No	No	Found in ponderosa pine, pinyon-juniper, Mexican woodland, and riparian areas with cottonwoods, sycamores, and willows; also have records from desertscrub and white fir habitats; elevational range of 1,320–9,800 feet amsl	Widespread in Arizona except for deserts in southwestern Arizona, most records from southern Colorado Plateau, Mogollon Rim, and adjacent mountain ranges	Possible to occur: Appleton Ranch, Lower San Pedro River, Dripping Springs
Ocelot (*Leopardus* (*Felis*) *pardalis*)	ESA: E (Cochise, Gila, Graham, Maricopa, Pima, Pinal, and Santa Cruz Counties) BLM: S	No	No	No	In Arizona, this species has typically been observed in subtropical thorn forest, thornscrub, and dense, brushy thickets at elevations below 8,000 feet amsl and is often found in riparian bottomlands. The critical habitat component is probably dense cover near the ground and complete avoidance of open country.	In Arizona, there are five recent confirmed sightings of ocelot in Cochise County (2009), the Huachuca Mountains (2011 and 2012), one near Globe (2010), Santa Rita Mountains (2014), and unconfirmed sightings in the Chiricahua and Peloncillo Mountains.	Possible to occur: Appleton Ranch, Lower San Pedro River, Dripping Springs
Lesser long-nosed bat (*Leptonycteris curasoae yerbabuenae*)	BLM: S	Yes, Appleton Ranch, Dripping Springs, Lower San Pedro River	Yes, Appleton Ranch (WestLand Resources Inc. 2004b)	Forage plants noted during site visits at Dripping Springs, Lower San Pedro River, and Appleton Ranch	Habitat consists of desert grasslands and shrublands in elevations ranging from 1,190–7,320 feet amsl; present only in summer	Species ranges from the Picacho Mountains south to the Agua Dulce Mountains, then east to the Chiricahua Mountains. Two records from the Phoenix area.	Possible to occur: Appleton Ranch, Lower San Pedro River, Dripping Springs
California leaf-nosed bat (*Macrotus californicus*)	BLM: S	Yes, Dripping Springs, Lower San Pedro River	No	No	Species prefers Sonoran desertscrub, roosts in mines, caves and rockshelters that have large areas of ceiling and flying space; elevational range of 160–3,980 feet amsl	Typically found south of the Colorado Plateau, year-round resident	Possible to occur: Appleton Ranch, Lower San Pedro River, Dripping Springs
Arizona myotis (*Myotis occultus*)	BLM: S	Yes, Appleton Ranch, Dripping Springs, Lower San Pedro River	No	No	Found in ponderosa pine and oak-pine woodlands near water, can also be found in riparian forests along the lower Colorado and Verde rivers; elevational ranges of 150–1,000 feet amsl (lower Colorado River) and 3,200–8,620 feet amsl	Found in higher elevations of central and eastern counties of Arizona as well as the lower Colorado River Valley	Possible to occur: Appleton Ranch, Lower San Pedro, Dripping Springs
Cave myotis (*Myotis velifer*)	BLM: S	Yes, Appleton Ranch, Dripping Springs, Lower San Pedro River	No	No	Habitat consist of creosote, brittlebush, palo verde, and cacti; roosts in caves, tunnels, mineshafts, under bridges and sometimes in buildings. Elevational range of 300–5,000 feet amsl.	Range is south of the Mogollon Plateau to Mexico, mostly summer resident except for a few that winter in southeastern Arizona	Possible to occur: Appleton Ranch, Lower San Pedro River, Dripping Springs

Common Name (*Scientific Name*)	Status*	HDMS Records within 2 miles	Baseline Data Records	Other Occurrence Records (eBird, SWCA or BLM Site Visits, Reptiles of Arizona)	Habitat Components (Elevation, Soils, Vegetation Association, Slope, Aspect, etc.)	Geographical Range in Arizona	Likelihood of Occurrence in BLM Offered Lands
Jaguar (*Panthera onca*)	ESA: E (Cochise, Pima, and Santa Cruz Counties) BLM: S	No	No	No	Variety of habitats, prefers lowland wet habitats but also occurs in drier habitats such as oak-pine woodlands; elevational range of sightings in Arizona were from 5,200–5,700 feet amsl	All documented sightings have been from southeastern Arizona	Possible to occur: Appleton Ranch, Lower San Pedro River
Reptiles							
Arizona striped whiptail (*Aspidoscelis arizonae*)	BLM: S	No	Yes, Appleton Ranch (Cogan 2012)	Reptiles of Arizona	Species prefers Semi-desert Grasslands in low valleys and sandy flats	Species only occurs near Willcox in Cochise County and in Whitlock Valley, Graham County	Unlikely to occur
New Mexico ridge-nosed rattlesnake (*Crotalus willardi obscurus*)	ESA: T (Cochise County) BLM: S	No	No	No	Habitat includes rocks, bunchgrass, and leaf litter in steep rocky canyons in the pine-oak and pine-fir belts at elevations of 5,600–9,000 feet amsl	Occurs only in the Pelloncillo Mountains of Cochise County	Unlikely to occur
Sonoran Desert tortoise (*Gopherus morafkai*)	BLM: S	Yes, Dripping Springs, Lower San Pedro River	No	Reptiles of Arizona	Habitat includes Mojave desert scrub to semidesert grassland and interior chaparral; elevational range of 510–5,300 feet amsl	Species occurs across much of the southern and southwest part of the state, ranging from Kingman to Yuma to Tucson	Possible to occur: Appleton Ranch, Lower San Pedro River, Dripping Springs
Sonora mud turtle (*Kinosternon sonoriense sonoriense*)	BLM: S	Yes, Appleton Ranch, Dripping Springs, Lower San Pedro River	No	Reptiles of Arizona	Species prefers rocky stream, creeks, rivers, ponds, cattle tanks, and ditches in habitats ranging from Sonoran desertscrub to woodlands; elevational range of sea level to 6,500 feet amsl	Occurs in southeastern Arizona and along and below the Mogollon Rim	Possible to occur: Appleton Ranch, Lower San Pedro River
Slevin's bunchgrass lizard (*Sceloporus slevini*)	BLM: S	Yes, Appleton Ranch	Yes, Appleton Ranch (Cogan 2012)	Reptiles of Arizona	Species prefers coniferous forests around bunchgrass in open sunny areas; elevational range of 4,300–9,480 feet amsl	Found only in the mountains of extreme southeast Arizona	Possible to occur: Appleton Ranch
Desert massasauga (*Sistrurus catenatus edwardsii*)	BLM: S	No	No	No	Species prefers tobosa grasslands in sloping bajadas with surface rocks; elevational range of 4,400–4,700 feet amsl	Occurs in extreme southeastern Arizona in San Bernardino and Sulphur Springs Valley	Unlikely to occur
Desert ornate box turtle (*Terrapene ornata*)	BLM: S	No	No	Reptiles of Arizona	Species prefers low valleys, plains, and bajadas in semi-desert grassland and Chihuahuan desertscrub habitat types; elevational range of 2,000–7,100 feet amsl	Species is found in southeast Arizona, ranging as far north as Winkelman	Possible to occur: Appleton Ranch, Lower San Pedro River
Northern Mexican gartersnake (*Thamnophis eques megalops*)	ESA: T (All counties except Maricopa and Yuma Counties) BLM: S	Yes, Appleton Ranch	Yes, Appleton Ranch (Cogan 2012)	Reptiles of Arizona	Species prefers cienegas, streams, and rivers in habitats ranging from upland Sonoran desertscrub to montane coniferous forests; elevational range of 1,000–6,700 feet amsl	Species is found along the Mogollon Rim and a few isolated populations in south-central Arizona	Possible to occur: Appleton Ranch
Narrow-headed gartersnake (*Thamnophis rufipunctatus*)	ESA: T (Apache, Coconino, Gila, Graham, Greenlee, Navajo, and Yavapai Counties) BLM: S	No	No	No	Species prefers pinyon-juniper and pine-oak woodlands, ranging into ponderosa pine at elevations between 2,440–8,080 feet amsl; species needs permanent water source	Species is found along the Mogollon Rim	Unlikely to occur

* Status Definitions

Endangered Species Act (ESA):

E = Endangered. Endangered species are those in imminent jeopardy of extinction. The ESA specifically prohibits the take of a species listed as endangered. Take is defined by the ESA as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to engage in any such conduct.

T = Threatened. Threatened species are those that are likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

ENE = Reintroduced populations designated as Experimental – Nonessential, under ESA.

Bureau of Land Management (BLM):

S = Sensitive. Species that could easily become endangered or extinct in the state.

Bald and Golden Eagle Protection Act (BGEPA):

Yes = A species protected by a United States Federal statute that protects two species of eagle.

Table B-5. Special status plant species analyzed for the offered lands parcels

Unless otherwise noted, range or habitat information is from the following sources: Arizona Heritage Data Management System (Arizona Game and Fish Department 2018a); USFWS Arizona Ecological Services Field Office (U.S. Fish and Wildlife Service 2016b); Tonto National Forest Final Assessment (U.S. Forest Service 2017d); Tonto National Forest Threatened, Endangered and Sensitive Species Abstracts (Tonto National Forest 2000); NatureServe (NatureServe 2018); Bureau of Land Management (Bureau of Land Management 2017b); Reptiles of Arizona (Brennan 2008); eBird (2018); (SEINet 2018)

Common Name (*Scientific Name*)	Status*	HDMS Records within 2 miles	Baseline Data Records	Other Occurrence Records (SEINet, NatureServe)	Habitat Components (Elevation, Soils, Vegetation Association, Slope, Aspect, etc.)	Geographical Range in Arizona	Likelihood of Occurrence in Offered Lands Analysis Area
Acuna cactus (*Echinomastus erectocentrus* var. *acunensis*)	ESA: E (Maricopa, Pima, and Pinal Counties) BLM: S	No	No	No	Occurs in valleys and on small knolls and gravel ridges of up to 30 percent slope in the Palo Verde-Saguaro Association of the Arizona Upland subdivision of the Sonoran Desert scrub. Elevation 1,190–3,773 feet amsl.	Found in Maricopa, western Pima, and Pinal Counties	Unlikely to occur
Alcove bog orchid (*Platanthera zothecina*)	CNF: S	No	No	No	Found at bases of alcove face-walls with flowing drip-line or with seepage down wall, shaded seeps, in dense vegetation or under rock debris, and in shaded sites along streams; elevation 3,950–6,400 feet amsl	Apache, Coconino, and Navajo Counties	Unlikely to occur
Aravaipa woodfern (*Thelypteris puberula* var. *sonorensis*)	TNF: S BLM: S	No	No	No	Meadows and seeps, wetland-riparian	Coconino, Graham, Pima, Pinal, and Yavapai Counties	Unlikely to occur
Arizona bugbane (*Actaea arizonica*)	CNF: S TNF: S	No	No	No	Mixed conifer and high-elevation riparian deciduous forests in deep shade and moist soils with high humus content, near perennial or intermittent streams or seeps, especially along bottoms and lower slopes of steep, narrow canyons; elevation 5,300–8,300 feet amsl	Coconino, Kaibab, and Tonto National Forests in central Arizona	Possible to occur: East Clear Creek
Arizona cliffrose (*Purshia subintegra*)	ESA: E (Graham, Maricopa, Mohave and Yavapai Counties)	No	No	No	Occurs at four widely separated areas across central Arizona, these sights differ slightly in elevation and associated vegetation. All sites have limestone soils derived from Tertiary lacustrine (lakebed) deposits.	Graham, Maricopa, Mohave, and Yavapai Counties	Unlikely to occur
Arizona eryngo (*Eryngium sparganophyllum*)	BLM: S	No	No	No	Riparian zones and marshes within pinyon-Juniper woodland and Madrean evergreen woodland. Elevation between 3,000–8,000+ feet amsl.	Cochise and Pima Counties	Unlikely to occur
Arizona hedgehog cactus (*Echinocereus triglochidiatus* var. *arizonicus*)	ESA: E (Maricopa, Pinal, and Gila Counties) BLM: S	Yes, Apache Leap	No	No	Found on dacite or granite bedrock, open slopes, in narrow cracks, between boulders, and in the understory of shrubs in the ecotone between Madrean evergreen woodland and Interior Chaparral. Elevation 3,200–5,200 feet amsl.	In Gila and Pinal Counties of central Arizona. Exact locations are not provided because illegal collecting threatens the species.	Known to occur: Apache Leap South
Arizona leatherflower (*Clematis Hirsutissima* var. *arizonica*)	CNF: S	No	No	No	Limestone-derived soils within ponderosa pine and pinyon pine, and Rocky Mountain juniper communities	Apache and Coconino Counties	Unlikely to occur
Arizona phlox (*Phlox amabilis*)	CNF: S TNF: S	No	No	Yes	Open, exposed, limestone-rocky slopes within pinyon-juniper woodlands and ponderosa pine-Gambel oak communities	Coconino, Gila, Graham, and Yavapai Counties	Possible to occur: Tangle Creek
Arizona rabbitbrush (*Chrysothamnus molestus*)	CNF: S	No	No	No	Rocky soils, mostly on limestone pinyon-juniper woodlands. Elevation between 5,905–7,875 feet amsl.	Only known from Coconino County.	Unlikely to occur
Arizona sneezeweed (*Helenium arizonicum*)	CNF: S	No	No	Yes	Roadsides and clearings in ponderosa forests and in regions of pine forests, especially around wet places such as bogs, ponds, lakes, and roadside ditches	Known almost exclusively from Coconino County, but also found in southern Apache, Gila, and possibly Navajo Counties	Possible to occur: East Clear Creek, Tangle Creek
Arizona Sonoran rosewood (*Vauquelinia californica* ssp. *sonorensis*)	BLM: S	No	No	Yes	Woodland or forest at base of cliffs, along canyon bottoms and on moderate to steep slopes of the Ajo Mountains. Elevation 2,300–4,800 feet amsl.	Cochise, Gila, Maricopa, Pima, and Pinal Counties	Known to occur: Apache Leap South
Arizona sunflower (*Helianthus arizonensis*)	CNF: S	No	No	No	Open pine woodlands. Elevation 3,935–6,885 feet amsl.	Apache, Coconino, Navajo, and Yavapai Counties	Unlikely to occur
Bartram stonecrop (*Graptopetalum bartramii*)	BLM: S	No	No	No	Sky island species growing on rocky outcrops along arroyos and canyons, often in shade and litter with Madrean evergreen woodland. Elevation 3,900–6,700 feet amsl.	Cochise, Pima, and Santa Cruz Counties	Unlikely to occur

Common Name (*Scientific Name*)	Status*	HDMS Records within 2 miles	Baseline Data Records	Other Occurrence Records (SEINet, NatureServe)	Habitat Components (Elevation, Soils, Vegetation Association, Slope, Aspect, etc.)	Geographical Range in Arizona	Likelihood of Occurrence in Offered Lands Analysis Area
Bebb's willow (*Salix bebbiana*)	CNF: S	No	No	No	Along stream channels, on the edges of drainages, along seeps, and in perched sites that appear to be receiving little water	Apache, Coconino, Navajo, and Yavapai Counties	Unlikely to occur
Blumer's dock (*Rumex orthoneurus*)	CNF: S TNF: S	No	No	Yes	Near perennial springs in unshaded meadows or along stream sides in canyons. In organic, moist soils. Elevation 6,490–9,030 feet amsl.	Apache, Coconino, Cochise, Gila, and Graham Counties	Known to occur: East Clear Creek
Chihuahua breadroot aka scurfpea (*Pediomelum pentaphyllum*)	BLM: S	No	No	No	Sandy, loamy soils	Cochise and Graham Counties	Unlikely to occur
Chihuahuan sedge (*Carex chihuahuensis*)	TNF: S	No	No	No	Stream banks, springs, and seeps. Elevation 1,100–8,000 feet amsl.	Cochise, Gila, Graham, Pima, and Santa Cruz Counties. Tonto National Forest: only found along Reynolds Creek.	Unlikely to occur
Chiricahua Mountain alumroot (*Heuchera glomerulata*)	TNF: S	No	No	No	Found on north-facing shaded rocky slopes, near seeps, springs and riparian areas, often in humus soil. Elevation 4,000–9,000 feet amsl.	Apache, Cochise, Greenlee, Gila, Graham, and Navajo Counties. Tonto National Forest: only found in Pinal Mountains	Unlikely to occur
Clifton rock daisy (*Perityle ambrosiifolia*)	BLM: S	No	No	No	Occurs in fissures and crevices in conglomerate rock near seeps and waterfalls; high desert above and riparian below	Species occurs on cliffs above Eagle Creek and San Francisco River in Greenlee County	Unlikely to occur
Cochise sedge (*Carex ultra*)*;* also (*Carex spissa* var. *ultra*)	CNF: S TNF: S BLM: S	No	No	No	Stream banks, wet seeps, sometimes on serpentine. Elevation lower than 1,970 feet amsl.	Apache, Cochise, Graham, Pima, Pinal, Santa Cruz and Yavapai Counties	Unlikely to occur
Countess Dalhousie's spleenwort (*Asplenium dalhousiae*)	BLM: S	No	No	No	Moist, rocky ravines, terrestrial among and at bases of rocks. Elevation 4,260–6,570 feet amsl.	Cochise and Pima Counties Only found in the Mule, Huachuca, and Baboquivari Mountains of southern Arizona	Unlikely to occur
Crenulate moonwort (*Botrychium crenulatum*)	CNF: S	No	No	No	Wet, marshy, and springy areas, including marshy meadows, edges of marshes, saturated soils of seeps, bottoms and stabilized margins of small streams. Sites partly to heavily shaded and usually have dense vegetation cover. Elevation 3,930–8,210 feet amsl.	Native, no county data	Unlikely to occur
Eastwood alum root (*Heuchera eastwoodiae*)	CNF: S TNF: S	No	No	No	Shaded, rocky slopes. Elevation 4,920–6,250 feet amsl.	Coconino, Gila, Maricopa, and Yavapai Counties	Unlikely to occur
Fickeisen plains cactus (*Pediocactus peeblesianus* var. *fickeiseniae*)	ESA: E (Coconino, Mohave, and Navajo Counties) BLM: S	No	No	No	Occurs on gravelly soils of alkaline desert scrub and desert grasslands; elevational range of 3,985–5,940 feet amsl.	Endemic to northern Arizona, found in Coconino, Mohave, and Navajo Counties	Unlikely to occur
Fish Creek fleabane (*Erigeron piscaticus*)	TNF: S BLM: S	No	No	No	Gravelly and sandy washes. Elevation 2,290–3,940 feet amsl.	Maricopa and Graham Counties	Unlikely to occur
Fish Creek rockdaisy (*Perityle saxicola*)	TNF: S	No	No	No	Cracks and crevices on very steep cliff faces, large boulders and rocky outcrops in canyons, and on buttes. Steep cliffs with generally east and northeast exposures, with slopes from 50 to 100 percent. Elevational range of 2,000–3,500 feet amsl.	Gila and Maricopa Counties. On Tonto National Forest occurs near Roosevelt Lake Dam and in Sierra Ancha Mountains, suspected to be in Superstition Mountains	Unlikely to occur
Flagstaff beardtongue (*Penstemon nudiflorus*)	CNF: S	No	No	No	Dry ponderosa pine forests in mountainous regions south of the Grand Canyon. Elevation 4,490–6,990 feet amsl.	Coconino, Navajo, and Yavapai Counties	Unlikely to occur
Flagstaff false pennyroyal (*Hedeoma diffusum*)	CNF: S	No	No	No	Rocky pavement, cliff, and limestone break habitats in the ponderosa pine vegetation type. Elevation 6,000–7,000 feet amsl.	Coconino, Navajo, and Yavapai Counties	Unlikely to occur
Galiuro aka Aravaipa sage (*Salvia amissa*)	TNF: S BLM: S	No	No	No	Stream banks and moist meadows in full sun or light shade. Elevation 1,509–3,010 feet amsl.	Cochise, Gila, and Graham Counties	Unlikely to occur
Gentry's indigobush (*Dalea tentaculoides*)	BLM: S	No	No	No	Canyon bottoms on cobble terraces subject to occasional flooding, in sandy, gravelly loam Rhyolite parent material. Elevation 3,600–4,600 feet amsl.	Pima, Cochise, and Santa Cruz Counties	Unlikely to occur

Common Name (*Scientific Name*)	**Status***	**HDMS Records within 2 miles**	**Baseline Data Records**	**Other Occurrence Records (SEINet, NatureServe)**	**Habitat Components (Elevation, Soils, Vegetation Association, Slope, Aspect, etc.)**	**Geographical Range in Arizona**	**Likelihood of Occurrence in Offered Lands Analysis Area**
Grand Canyon century plant aka Phillip's agave (*Agave phillipsiana*)	CNF: S	No	No	No	Sandy to gravelly places with desert scrub. Elevation 2,290–3,610 feet amsl.	Known only from four sites within Grand Canyon National Park	Unlikely to occur
Heathleaf wild buckwheat (*Eriogonum ericifolium* var. *ericifolium*)	CNF: S	No	No	No	Gravelly or rocky slopes of lacustrine silt, mixed grasslands, chaparral and oak-woodlands. Elevation 2,950–3,610 feet amsl.	Coconino, Pima, and Yavapai Counties	Unlikely to occur
Hohokam agave aka. Murphey agave (*Agave murpheyi*)	TNF: S BLM: S	No	No	No	Mountainous slopes in dry chaparral and desert areas. Near drainage systems in desert scrub. Elevation 1,310–3,280 feet amsl.	Gila, Maricopa, Pinal, and Yavapai Counties	Possible to occur: Apache Leap South, Cave Creek
Huachuca golden aster (*Heterotheca rutteri*)	BLM: S	No	No	No	Grasslands with mesquite, grassy understory in oak woodlands, grassy floodplains, sandy, loamy soils. Elevation 3,280–4,920 feet amsl.	Cochise, Santa Cruz, and Pima Counties	Possible to occur: Appleton Ranch
Huachuca Mountain milkvetch (*Astragalus hypoxylus*)	BLM: S	No	No	No	Oak woodland with south to southwest exposures. Elevation 5,300–5,500 feet amsl.	Santa Cruz and Cochise Counties	Unlikely to occur
Huachuca water umbel (*Lilaeopsis schaffneriana* ssp. *recurva*)	ESA: E (Cochise, Pima, and Santa Cruz Counties) BLM: S	No	Appleton Ranch (WestLand Resources Inc. 2004b)	No	The majority of this species occur along the San Pedro River, in the Huachuca Mountains, and along Cienega Creek in the San Pedro River and Santa Cruz River watersheds	Occurs on lands administered by the U.S. Army Fort Huachuca, the Forest Service, the BLM, the U.S. Fish and Wildlife Service, Arizona Parks, Pima County, The Nature Conservancy, and private landowners	Unlikely to occur
Kearney's blue star (*Amsonia kearneyana*)	BLM: S	No	No	No	Stable alluvial deposits of small boulders and cobbles along a dry wash. Grows in full sun or partial shade in riparian vegetation zone surrounded by Sonoran Desert Scrub.	Found only in Pima County	Unlikely to occur
Lace-leaf rockdaisy (*Perityle ambrosiifolia*)	BLM: S	No	No	No	In fissures and crevices of north- or east-facing cliffs and canyon walls; conglomerate, sandstone, or rhyolite rock, often near seeps and waterfalls. Found within pinyon-juniper grassland communities. Elevation 1,640–4930 feet amsl.	Greenlee County	Unlikely to occur
Lyngholm's cliffbrake (*Pellaea lyngholmii*)	CNF: S	No	No	No	Rocky slopes and ledges, usually on sandstone. Elevation 3,935–5905 feet amsl.	Coconino and Yavapai Counties	Unlikely to occur
Mapleleaf false snapdragon (*Mabrya acerifolia*)	TNF: S	No	No	No	Occurs on rock overhangs and in bare rock/talus/scree, cliff, and desert habitats. Elevation around 2,000 feet amsl.	Maricopa and Pinal Counties; all localities occur in the Mesa Ranger District	Unlikely to occur
Mearns' bird-foot trefoil aka horseshoe deer vetch (*Lotus mearnsii* var. *equisolensis*)	TNF: S	No	No	No	Desert scrub growing on late Tertiary lacustrine deposits at an elevation of 2,100 feet amsl	Known only from Horseshoe Reservoir, Maricopa County	Unlikely to occur
Metcalfe's tick-trefoil (*Desmodium metcalfei*)	CNF: S	No	No	No	Rocky slopes and canyons in grasslands, oak-pinyon-juniper woodlands, and riparian forests. Elevation between 4,000–6,500 feet amsl.	Cochise, Coconino, Gila, Pinal, Santa Cruz and Yavapai Counties	Unlikely to occur
Mogollon thistle (*Cirsium parryi* ssp. *mogollonicum*)	CNF: S	No	No	No	Moist to very moist soils in riparian understory of perennial stream with ponderosa pine, Douglas-fir, and white fir. Elevation 7,200 feet amsl.	Endemic to <1 square mine in Dane Canyon in Coconino County	Unlikely to occur
Mt. Dellenbaugh sandwort (*Arenaria aberrans*)	CNF: S	No	No	No	Oak and pine forests, mixed forests/woodland	Gila and Yavapai Counties	Unlikely to occur
Nichol's Turk's head cactus (*Echinocactus horizonthalonius* var. *nicholii*)	ESA: E (Maricopa, Pima, and Pinal Counties) BLM: S	No	No	No	Found on limestone substrates along dissected alluvial fans, inclined terraces and saddles, bajadas, and debris flow. It grows in open areas and partially to shaded areas underneath the canopy of shrubs and trees, or sheltered next to rocks on steep slopes and within limestone outcrops. Occurs within the Upland Division of Sonoran Desert scrub on 0 to 30 percent slopes with north-, west-, and south-facing exposure. Elevation 2,400–4,000 feet amsl.	Endemic to the Sonoran Desert and occurs on isolated mountain ranges within south-central Arizona in Pima and Pinal Counties	Unlikely to occur

Common Name (*Scientific Name*)	Status*	HDMS Records within 2 miles	Baseline Data Records	Other Occurrence Records (SEINet, NatureServe)	Habitat Components (Elevation, Soils, Vegetation Association, Slope, Aspect, etc.)	Geographical Range in Arizona	Likelihood of Occurrence in Offered Lands Analysis Area
Page Springs agave (*Agave yavapaiensis*)	CNF: S	No	No	No	Rocky, clayey-loamy igneous derived soils, less frequently on limestone soils in semi-arid desert grassland to pinyon-juniper woodland	Known only from 10 populations occurring near habitation and agricultural and archaeological sites associated with pre-Columbian cultures	Unlikely to occur
Peebles Navajo cactus (*Pediocactus peeblesianus* var. *peeblesianus*)	ESA: E (Navajo County) BLM: S	No	No	No	Weakly alkaline, gravelly soils where the host gravel can occur on a variety of substrates. Elevation between 5,400 and 5,600 feet amsl.	Central Navajo County, near Holbrook, Arizona	Unlikely to occur
Parish's Indian mallow (*Abutilon parishii*)	TNF: S BLM: S	No	No	No	Mountain slopes and desert scrublands. Elevation is 3,280 feet amsl.	Found in Maricopa, Gila, Graham, Pima, Pinal, and Yavapai Counties	Possible to occur: Apache Leap South, Dripping Springs
Pima pineapple cactus (*Coryphantha scheeri* var. *robustispina*)	BLM: S	No	No	No	Alluvial valleys, mesas, and hillsides in desert, desert grassland, or southwestern oak woodlands. Soils range from shallow to deep, and silty to rocky, with a preference for silty to gravelly deep alluvial soils. Elevation 2,290–4,920 feet amsl.	Pima and Santa Cruz Counties	Unlikely to occur
Ripley's wild buckwheat (*Eriogonum ripleyi*)	CNF: S TNF: S	No	No	No	Sandy clay flats and slopes on edges of sandstone outcrops, oak-juniper woodlands. Elevation 3,280–6,235 feet amsl.	Known only from two areas in Arizona: one near Frazier's Well in Coconino County and a second in the Verde Valley area of southeastern Yavapai and extreme northwestern Maricopa County	Unlikely to occur
Rock fleabane (*Erigeron saxatilis*)	CNF: S	No	No	Yes	Shaded canyon walls, moist north-facing slopes, and steep rock outcrops and boulders in the stream beds of shady canyons. Elevation 4,390–6,990 feet amsl.	Coconino, Gila, and Yavapai Counties	Known to occur: East Clear Creek
Round dunebroom (*Errazurizia rotundata*)	BLM: S	No	No	No	Sandy areas or in crevices of rock on rocky hilltops and ledges.	Coconino and Navajo Counties	Unlikely to occur
Rusby's milk-vetch (*Astragalus rusbyi*)	CNF: S	No	No	No	Meadows in yellow pine forest or edge of thickets and aspen groves, in dry or temporarily moist basaltic soils; elevational range of 5,400–8,000 feet amsl.	Occurs in the Flagstaff area and the lower slopes of the San Francisco Peaks descending into Oak Creek Canyon, in Coconino County	Unlikely to occur
Rusby's milkwort (*Polygala rusbyi*)	CNF: S TNF: S	No	No	No	Desert grasslands and juniper woodlands. Elevation 3,000–5,000 feet amsl.	Maricopa, Mohave, and Yavapai Counties	Unlikely to occur
Salt River rock daisy (*Perityle gilensis* var. *salensis*)	TNF: S	No	No	No	Crevices on cliff faces, ledges, and rock outcrops in Mojave Sonoran desert scrub, semi-desert grassland, juniper grass, and interior chaparral associations	Only two known sites, located along the Salt River Canyon.	Unlikely to occur
San Francisco Peaks groundsel (*Packera franciscana*)	ESA: T (Coconino County)	No	No	No	Talus slopes, rock crevices, above timberline. Elevation 10,500–12,470 feet amsl.	Known only from above timberline in the San Francisco Peaks	Unlikely to occur
San Pedro River wild buckwheat (*Eriogonum terrenatum*)	BLM: S	No	No	No	Clayey slopes and flat, creosote bush communities. Elevation 3,280–3,940 feet amsl.	Pima and Cochise Counties	Unlikely to occur
Sierra Ancha fleabane (*Erigeron anchana*)	TNF: S	No	No	No	Rock crevices and ledges on boulders or on vertical cliff faces, usually in canyons. Granite cliff faces, chaparral through pine forests.	Found in Gila County in the Sierra Ancha, Mazatzal, and Mescal Mountains as well as Pine Creek	Unlikely to occur
Sunset Crater beardtongue (*Penstemon clutei*)	CNF: S	No	No	No	Volcanic cinder cones, either in open areas or under ponderosa pines in spots without leaf litter. Elevation is 6,988 feet amsl.	Near Sunset Crater in Coconino County	Unlikely to occur
Texas purple-spike (*Hexalectris warnockii*)	BLM: S	No	No	No	Shaded slopes and dry, rocky creek beds in canyons, in leaf mold in oak-juniper-pinyon pine woodlands. Elevation 1,965–6,565 feet amsl.	Found in Cochise County	Unlikely to occur
Tonto Basin agave (*Agave delamateri*)	CNF: S TNF: S	No	No	No	Gravelly places with desert scrub, rarely in chaparral or pinyon-juniper woodlands. Elevation 2,295–5,250 feet amsl.	Gila, Maricopa, and Yavapai Counties	Possible to occur: Turkey Creek
Toumey's groundsel (*Packera neomexicana* var. *toumeyi*)	TNF: S	No	No	No	Found in oak chaparral and occasionally pine forest; elevational range of 3,000–9,000 feet amsl.	Cochise and Gila Counties, on Tonto National Forest found in the Pinal Mountains	Unlikely to occur

Common Name (*Scientific Name*)	Status*	HDMS Records within 2 miles	Baseline Data Records	Other Occurrence Records (SEINet, NatureServe)	Habitat Components (Elevation, Soils, Vegetation Association, Slope, Aspect, etc.)	Geographical Range in Arizona	Likelihood of Occurrence in Offered Lands Analysis Area
Tumamoc globeberry (*Tumamoca macdougalii*)	BLM: S	No	No	No	Semidesert grasslands, sandy washes and gullies, Sonoran desert scrub	Maricopa, Pima, and Pinal Counties	Unlikely to occur
Verde breadroot (*Pediomelum verdiense*)	TNF: S	No	No	No	Sonoran desert scrub or scattered juniper communities on Verde limestone or compacted roadsides	Yavapai County	Unlikely to occur
Verde Valley sage (*Salvia dorrii* ssp. *mearnsii*)	CNF: S	No	No	No	Sandy, rocky, or limestone soil on dry open slopes, and on flats or foothills. Elevation 960–9,800 feet amsl.	Coconino and Yavapai Counties	Unlikely to occur

* Status Definitions

Endangered Species Act (ESA):

E = Endangered. Endangered species are those in imminent jeopardy of extinction. The ESA specifically prohibits the take of a species listed as endangered. Take is defined by the ESA as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to engage in any such conduct.

T = Threatened. Threatened species are those that are likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

Tonto National Forest (TNF):

S = Sensitive. Species identified by a Regional Forester for which population viability is a concern, as evidenced by: a. significant current or predicted downward trends in population number or density. B. Significant current or predicted downward trends in habitat capability that would reduce a species' existing distribution.

Coronado National Forest (CNF):

S = Sensitive. Species identified by a Regional Forester for which population viability is a concern, as evidenced by: a. significant current or predicted downward trends in population number or density. B. Significant current or predicted downward trends in habitat capability that would reduce a species' existing distribution.

Bureau of Land Management (BLM): Sensitive species were included from the Gila District Office

S = Sensitive. Species that could easily become endangered or extinct in the state.

Table B-6. Noxious and invasive weed species analyzed for the offered lands parcels

Common Name	Scientific Name	Status	Habitat Components (Elevation, Soils, Veg Association, Slope, Aspect, etc.)	Geographical Range in Arizona	Likelihood of Occurrence
African rue	*Peganum harmala*	TNF Arizona Department of Agriculture (ADA)	Favors disturbed and barren areas with moist soil such as roadsides, riparian corridors, and irrigation ditches; will grow in alkaline soils and high saline soils (U.S. Forest Service 2014a). Typically occurs below 4,500 feet amsl elevation; and seeds can germinate under fairly saline conditions (White 2013).	Maricopa County (Natural Resources Conservation Service 2018a). Also has been observed in Pima County along Interstate 10 near Vail, but not on Tonto National Forest (Tonto National Forest 2018).	Unlikely to occur (all). All distant to known occurrences (SEINet 2018; Tonto National Forest 2018).
African sumac	*Rhus lancea*	TNF	Occurs in well-drained sites in woodlands, grassland margins, and riparian communities; occurs in disturbed, degraded, or cultivated sites, typically below 2,000 feet amsl (White 2013).	The USDA PLANTS database indicates that there are no records in Arizona (Natural Resources Conservation Service 2018a). No records on Tonto National Forest (Tonto National Forest 2018). However, a recent record occurs in Cave Creek approximately 3 miles downstream of the Cave Creek parcel (SEINet 2018).	May occur • Cave Creek Nearest occurrence is within 3 miles (SEINet 2018) and suitable habitat may occur. Unlikely to occur • Tangle Creek • Turkey Creek • Apache Leap South Sites more than 15 miles from known occurrences (SEINet 2018).
Alligator weed	*Alternanthera philoxeroides*	ADA	Occurs in both aquatic and terrestrial habitats, often where aquatic and terrestrial habitat interface; occurs in riparian areas, canals, rivers, ditches, wetter pastures, and irrigated crops; can tolerate cold winters but cannot withstand prolonged freezing temperatures; prefers eutrophic conditions, but can survive in areas with low nutrient availability (CABI 2018).	No record in Arizona (CABI 2018; Natural Resources Conservation Service 2018a)	Unlikely to occur (all). This species is not known to occur in Arizona.
Anchored water hyacinth	*Eichhornia azurea*	Federal ADA	Freshwater, perennial, aquatic plant found in permanent water bodies, prefers open, slow-moving water environments (CABI 2018).	No record in Arizona (Natural Resources Conservation Service 2018a)	Unlikely to occur (all). This species is not known to occur in Arizona.
Arabian schismus	*Schismus arabicus*	TNF	Occurs in disturbed, degraded, or cultivated sites in desert and semidesert grassland communities and along roadsides, typically below 4,500 feet amsl (White 2013).	Has occurrence records in Cochise, Maricopa, Mojave, Pima, and Pinal Counties (Natural Resources Conservation Service 2018a)	Unlikely to occur (all). Turkey Creek occurs above the typical elevational range of this species. Cave Creek, Tangle Creek, and Apache Leap South are all distant from known occurrences (SEINet 2018) and do not occur in areas with high disturbance levels or along roads.
Asian mustard [Sahara mustard]	*Brassica tournefortii*	TNF	Occurs in areas with windblown sediments and disturbed areas within desert grasslands, desert scrub, and roadsides at elevations typically below 2,600 feet amsl (White 2013).	Has occurrence records in Maricopa, Pima, Pinal, and Yuma Counties (Natural Resources Conservation Service 2018a). Widespread throughout Tonto National Forest (Tonto National Forest 2018).	May occur • Cave Creek • Tangle Creek Contains suitable grassland or desertscrub habitat, has occurrences in vicinity (SEINet 2018), and is within or just above elevational range Unlikely to occur • Turkey Creek Does not contain suitable habitat and is above typical elevational range. Unlikely to occur • Apache Leap South Does not contain disturbed areas or roadsides and is well above typical elevational range.
Austrian fieldcress [Austrian yellowcress]	*Rorippa austriaca*	ADA	Perennial that occurs in wet soil, on disturbed and cultivated sites including roadsides, fields, and mud flats; prefers soils that are wet 6–8 months of the year (University of Nevada Reno 2004).	No records in Arizona (Natural Resources Conservation Service 2018a).	Unlikely to occur (all). This species is not known to occur in Arizona.
Black mustard	*Brassica nigra*	TNF	Occurs in dry disturbed sites such as along roadsides, railroad rights-of-way, pastures, and waste places at elevations below 7,000 feet amsl (White 2013).	Has occurrence records in Cochise, Coconino, Maricopa, Pima, and Pinal Counties (Natural Resources Conservation Service 2018a). Occurs along State Route 188 through Tonto Basin, and along State Route 87 within Tonto National Forest (Tonto National Forest 2018).	Unlikely to occur • Cave Creek • Tangle Creek • Apache Leap South • Turkey Creek These sites do not contain suitable disturbed areas, and recent occurrences in the project vicinity occur on roadsides (SEINet 2018).

Common Name	Scientific Name	Status	Habitat Components (Elevation, Soils, Veg Association, Slope, Aspect, etc.)	Geographical Range in Arizona	Likelihood of Occurrence
Blue mustard	*Chorispora tenella*	TNF	Occurs in disturbed sites including waste places, pastures, roadsides, and railroad rights-of-way, typically below 7,500 feet amsl (White 2013).	Has occurrence records in Apache, Coconino, Maricopa, Navajo, and Yavapai Counties (Natural Resources Conservation Service 2018a). Has been found outside of the Tonto National Forest along State Route 69 between Cordes Junction and Prescott; in Prescott; and north of Holbrook (Tonto National Forest 2018).	Unlikely to occur • Cave Creek • Tangle Creek • Apache Leap South • Turkey Creek These sites do not contain suitable disturbed areas, and occurrences are distant to project areas (SEINet 2018).
Branched broomrape [hemp broomrape]	*Orobanche ramosa*	Federal ADA	Requires relatively high temperatures for optimum germination and growth and occurs mainly in irrigated crops grown under summer conditions in tropical and sub-tropical climates. Adapted to soils of generally high PH and are associated with the crops they attack (CABI 2018).	No record in Arizona (Natural Resources Conservation Service 2018a).	Unlikely to occur (all). This species is not known to occur in Arizona.
Buffelgrass	*Pennisetum ciliare*	TNF ADA	Alkaline soils and within arid areas with high nutrients and moisture (Allen 2017). Extremely drought tolerant and reestablishes quickly and expands infestation following fire (Tonto National Forest 2018).	Has occurrence records in Maricopa, Pima, Pinal, and Yuma Counties (Natural Resources Conservation Service 2018a). Common in Phoenix, and spreading onto Tonto National Forest along State Routes 60 and 87, Pima Road in Scottsdale, Cave Creek Road, and others (Tonto National Forest 2018).	May occur • Cave Creek • San Pedro River Near known occurrences and/or are in close proximity to a main road which may serve as a vector for this species or close to a known occurrence (SEINet 2018; Tonto National Forest 2018) Unlikely to occur • Tangle Creek • East Clear Creek • Turkey Creek • Apache Leap South • Dripping Springs Distant from main roads that could serve as a vector for this species. Unlikely to occur • Appleton Ranch parcels No records in vicinity (SEINet 2018).
Bull thistle	*Cirsium vulgare*	TNF	Occurs most often in areas that have been recently or repeatedly disturbed (e.g., overgrazed rangelands, recently burned forests, clear-cuts, and along roads and ditches); prefers soil of intermediate moisture (U.S. Forest Service 2018d). Typically occurs at elevations between 4,500 and 9,100 feet amsl (White 2013).	Has occurrence records in Apache, Cochise, Coconino, and Navajo Counties (Natural Resources Conservation Service 2018a). Common from Flagstaff to south of Mogollon Rim (Tonto National Forest 2018).	Unlikely to occur • Tangle Creek • Turkey Creek • Apache Leap South • Dripping Springs • East Clear Creek At least 10 miles from known occurrences (SEINet 2018). No recent burns, or repeatedly disturbed areas occur in the parcels.
Burclover	*Medicago polymorpha*	ADA	Occurs in cultivated, disturbed, or degraded sites along roadsides and within meadows, grasslands, woodlands, and forest communities, typically between 4,000 and 8,000 feet amsl (White 2013).	Has occurrence records in Apache, Cochise, Gila, Maricopa, Pima, Pinal, and Yavapai Counties (Natural Resources Conservation Service 2018a).	Unlikely to occur • East Clear Creek • Turkey Creek • Apache Leap South • Appleton Ranch • Dripping Springs Distant from known records (SEINet 2018). Unlikely to occur • Cave Creek • San Pedro River • Tangle Creek Recent records in vicinity (SEINet 2018) but well below typical elevational range.

Common Name	Scientific Name	Status	Habitat Components (Elevation, Soils, Veg Association, Slope, Aspect, etc.)	Geographical Range in Arizona	Likelihood of Occurrence
Camelthorn	*Alhagi maurorum*	TNF ADA	Occurs in moist sites that are cultivated, disturbed or degraded; typically found at 4,500–5,000 feet amsl within meadows, grasslands, and riparian communities (White 2013).	Has occurrence records in Apache, Coconino, Gila, Maricopa, and Navajo Counties (Natural Resources Conservation Service 2018a). Heavy infestations in northeastern part of state; near Painted Rock Dam; southwest of Phoenix; west of Phoenix near Loop 101; Chandler; Highway 60 just north of Globe; Highway 60 north of the Salt River; but, not yet on Tonto National Forest (Tonto National Forest 2018).	Unlikely to occur (all). All sites are distant from known occurrence records (SEINet 2018; Tonto National Forest 2018). Does not occur in grassland or meadow habitat; outside of typical elevation range: • Cave Creek • Tangle Creek • Dripping Springs • San Pedro River Do not contain suitable degraded moist habitat: • Apache Leap South • Appleton Ranch parcels Outside typical elevation; habitat not degraded, disturbed, or cultivated: • Turkey Creek • East Clear Creek
Canada thistle	*Cirsium arvense*	TNF ADA	Occurs most commonly in disturbed upland areas (e.g., barrens, meadows, fields, pastures), but can also invade wet areas with fluctuating water levels (U.S. Forest Service 2018d). Typically occurs at elevations 4,200–8,300 feet amsl (White 2013).	Has occurrence records in Apache, Coconino, and Yavapai Counties (Natural Resources Conservation Service 2018a). Occurs in northeast part of state, and near the OW Ranch, west of Canyon Creek on the Tonto National Forest (Tonto National Forest 2018).	Unlikely to occur • Cave Creek • Tangle Creek • Apache Leap South • Turkey Creek • Dripping Springs • San Pedro River • Appleton Ranch Parcels distant from known locations (SEINet 2018; Tonto National Forest 2018). Unlikely to occur • Turkey Creek • East Clear Creek Known occurrence about 10 miles southwest of parcel (SEINet 2018); however, site not disturbed.
Carolina horsenettle	*Solanum carolinense*	ADA	Occurs in cultivated, disturbed, or degraded sites along roadsides and within grassland and woodland communities; prefers sandy, well-drained soils at elevations from 4,000 to 5,000 feet amsl (White 2013).	In Arizona, known only one site along Queen Creek (SEINet 2018).	Unlikely to occur (all). Sites are distant from only known occurrence in Arizona (SEINet 2018).
Common purslane [little hogweed]	*Portulaca oleracea*	ADA	Occurs in cultivated, disturbed, or degraded sites along roadsides and within meadows, grassland, woodland, and forest communities; can be found in soil containing loam, sand, or gravelly material at elevations from 4,000 to 8,500 feet amsl; can tolerate heat and drought (White 2013).	Observed in all Arizona counties except La Paz, Pinal, and Yuma (Natural Resources Conservation Service 2018a).	Known to occur on Appleton Ranch NE parcel (SEINet 2018). May occur • Tangle Creek Despite being distant to known occurrences, this parcel contains well-used roads and is within typical elevational range: Unlikely to occur • San Pedro River It contains suitable disturbed habitat and is within 10 miles of documented occurrences (SEINet 2018); however, it is found within Sonoran desertscrub biotic community and is well below the typical elevation for this species. Unlikely to occur • Cave Creek • East Clear Creek • Turkey Creek • Apache Leap South • Dripping Springs Parcels do not contain suitable disturbed or degraded habitat, and roads within or near the parcel appear to be minor and seldom used.

Common Name	Scientific Name	Status	Habitat Components (Elevation, Soils, Veg Association, Slope, Aspect, etc.)	Geographical Range in Arizona	Likelihood of Occurrence
Common teasel [Fuller's teasel]	*Dipsacus fullonum*	TNF	Prefers open, sunny habitats and commonly occurs in disturbed areas including roadsides and pastures; grows in both moist and arid soils, but more commonly found in mesic soils (U.S. Forest Service 2014b). Typically occurs at elevations ranging from 4,700 to 8,700 feet amsl (White 2013).	Has occurrence records in Coconino County (Natural Resources Conservation Service 2018a). Occurs at Watson Woods on Granite Creek near Prescott; at Shumway Millsite, south of Payson and at Sharp Creek Campground on Tonto National Forest (Tonto National Forest 2018).	May occur • Turkey Creek Is within the typical elevational range and is approximately 7 miles north of the nearest occurrence (SEINet 2018). Unlikely to occur • Cave Creek • Tangle Creek • Apache Leap South • East Clear Creek These sites do not contain suitable disturbed roadsides or pastures, and are distant from recent occurrences (SEINet 2018).
Creeping wart cress [Greater swinecress]	*Coronopus squamatus*	ADA	Occurs in disturbed areas, including agricultural fields, orchards, turf, roadsides, banks of ditches; tolerates saline soil (Winston et al. 2014).	No records in Arizona (CABI 2018; Natural Resources Conservation Service 2018a).	Unlikely to occur (all). This species is not known to occur in Arizona.
Dalmatian toadflax	*Linaria dalmatica*	TNF ADA	Occurs in cultivated, disturbed, or degraded sites along roadsides and within meadows, grassland, woodland, and riparian communities at elevations ranging from 4,400 to 10,000 feet amsl (White 2013).	Has occurrence records in Coconino and Yavapai Counties (Natural Resources Conservation Service 2018a). Common around Flagstaff; widespread in ponderosa pine forests on Kaibab, Coconino, and Prescott National Forests; on Tonto National Forest, grows at Hot Shot Base, along State Route 87 between Payson and Rye, and near the Verde River 1 mile downstream of Childs (Tonto National Forest 2018).	Unlikely to occur • Cave Creek • Tangle Creek • Dripping Springs • San Pedro River Well below elevational range Unlikely to occur • Apache Leap South • East Clear Creek • Appleton Ranch parcels Known occurrences are at least 15 miles from parcels (SEINet 2018; Tonto National Forest 2018).
Diffuse knapweed	*Centaurea diffusa*	TNF ADA	Prefers well-drained soils within cultivated, disturbed, or degraded sites along roadsides or within meadows, grassland, woodland, and forest communities at elevations typically below 7,200 feet amsl (White 2013).	Has occurrence records in Apache County (Natural Resources Conservation Service 2018a). Common on private lands in Young; on Tonto National Forest occurs at Pleasant Valley airport; Pleasant Valley Ranger Station, along Cherry Creek, and along Highway 288 at Board Tree Saddle (south of Young) (Tonto National Forest 2018).	Unlikely to occur. Cave Creek • Tangle Creek • East Clear Creek • South Apache Leap • San Pedro River • Appleton Ranch parcels • Dripping Springs Distant from known occurrences (SEINet 2018; Tonto National Forest 2018). Unlikely to occur • Turkey Creek Site is approximately 12 miles southwest of the nearest occurrences, and does not contain suitable disturbed or degraded habitat.
Dodder	*Cuscuta* spp. (except for natives)	Federal ADA	Alluvium, sandy soils, desert shrub community (NatureServe 2018). Parasitic annual plant species, some of which infest crops, and some that infest salty marshes, flats, or ponds (University of California Statewide Integrated Pest Management Program 2017).	Has occurrence records in all counties except Apache, Graham, and Greenlee (Natural Resources Conservation Service 2018a).	May occur (all). *Cuscuta* spp. is widespread and species inhabit a wide variety of habitats, and have occurrence records throughout Arizona (SEINet 2018). Unlikely to occur • East Clear Creek
Downy brome [cheatgrass]	*Bromus tectorum*	TNF	Occurs from valley bottoms to high mountainous areas; quickly invades disturbed sites. Prefers well-drained soils of any texture but is not well adapted to saline or sodic soil conditions or wet soil (Natural Resources Conservation Service 2018a).	Has occurrence records in all counties except Cochise, Greenlee, La Paz, Pinal, Santa Cruz, and Yuma (Natural Resources Conservation Service 2018a).	May occur. • Cave Creek • Apache Leap South • Turkey Creek • Tangle Creek • East Clear Creek This species is widespread and does not appear to be limited to paved roadsides or extremely disturbed areas (SEINet 2018).

Common Name	Scientific Name	Status	Habitat Components (Elevation, Soils, Veg Association, Slope, Aspect, etc.)	Geographical Range in Arizona	Likelihood of Occurrence
Dryer's woad	*Isatis tinctoria*	TNF ADA	Occurs in cultivated, disturbed, or degraded sites along roadsides and within grassland or woodland communities; prefers dry rocky or sandy soils at elevations from 4,300 to 7,000 feet amsl (White 2013).	No records in Arizona (Natural Resources Conservation Service 2018a).	Unlikely to occur (all). This species is not known to occur in Arizona.
Dudaim melon [cantaloupe]	*Cucumis melo*	ADA	Occurs in disturbed areas with abundant moisture, including fields, roadsides, and ditches (Winston et al. 2014).	No records in Arizona (Natural Resources Conservation Service 2018a; Winston et al. 2014).	Unlikely to occur (all). This species is not known to occur in Arizona.
Field bindweed	*Convolvulus arvensis*	TNF ADA	Occurs in cultivated, disturbed, or degraded sites along roadsides and within grassland, chaparral, woodland, forest, and riparian communities at elevations ranging from 3,500 to 10,000 feet amsl (White 2013).	Has occurrence records in all Arizona counties (Natural Resources Conservation Service 2018a).	May occur • San Pedro River • Appleton Ranch parcels • Tangle Creek • Turkey Creek Although some parcels below typical elevational range, they contain suitable disturbed habitat, and there are occurrence records nearby (SEINet 2018). Unlikely to occur • Cave Creek • East Clear Creek • Apache Leap South • Dripping Springs Distant from known occurrences (SEINet 2018) and minimal disturbed habitat.
Field sandbur	*Cenchrus spinifex [incertus]*	TNF ADA	Prefers sandy or gravelly sites that have been disturbed, or degraded sites at elevations between 3,500 and 5,000 feet amsl (White 2013).	Has occurrence records in all counties except La Paz, Pinal, and Yuma (Natural Resources Conservation Service 2018a). Occurs east of Tonto National Forest on the Fort Apache Reservation along the right-of-way for Highway 60 east; Occurs on Tonto National Forest on right-of-way of State Route 188, a few miles north of Globe, Arizona (Tonto National Forest 2018).	May occur • Appleton Ranch parcels May contain suitable degraded sandy or gravelly sites, and there are known occurrences approximately 3.5 miles north of the parcels (SEINet 2018). Unlikely to occur • Tangle Creek • Cave Creek • East Clear Creek • Apache Leap South • Turkey Creek • San Pedro River • Dripping Springs Distant from known occurrences (SEINet 2018; Tonto National Forest 2018).
Five-stamen tamarisk	*Tamarix chinensis*	TNF	Desert riparian habitats, including seeps, springs, and roadsides; may tolerate saline soil (CABI 2018).	Has occurrence records in all Arizona counties except Greenlee, La Paz, Pinal, and Yuma (Natural Resources Conservation Service 2018a). On Tonto National Forest, saltcedar occurs along the Verde River and its tributaries; along much of the Salt River; and along Salt and Verde River reservoirs (Tonto National Forest 2018).	May occur • Cave Creek • Tangle Creek • Turkey Creek This species occurs in Cave Creek approximately 3 miles south of the parcel (SEINet 2018), and may occur at Tangle Creek and Turkey Creek, if sufficient water occurs. Unlikely to occur • Apache Leap South • East Clear Creek Lacks riparian habitat or roadsides.

Common Name	Scientific Name	Status	Habitat Components (Elevation, Soils, Veg Association, Slope, Aspect, etc.)	Geographical Range in Arizona	Likelihood of Occurrence
Fountain grass	*Pennisetum setaceum*	TNF	Usually found along roadways or in rangelands. Prefers arid to semi-arid conditions, but can occur in mesic environments; usually occurs in areas with mild winters and summer moisture; prefers open, sunny areas with well-drained soils (CABI 2018).	Has occurrence records in Cochise, Maricopa, Pima, and Santa Cruz Counties (Natural Resources Conservation Service 2018a). Documented in all desert districts within the Tonto National Forest; very abundant along Highway 60 between Superior and mountain tunnel; also occurs along State Route 87, along the road to Bartlett and Horseshoe Reservoirs, and in the Salt River Recreation Area (Tonto National Forest 2018).	May occur • Apache Leap South • Cave Creek Contain suitable habitat and have occurrence records within approximately 2 miles (SEINet 2018). Unlikely to occur • Tangle Creek • Turkey Creek • East Clear Creek These sites are distant from known occurrences, and do not contain suitable habitat (SEINet 2018).
Floating water hyacinth	*Eichhornia crassipes*	ADA	Aquatic, floating plant that occurs in tropical and subtropical freshwater lakes and rivers (CABI 2018).	Has occurrence records in Maricopa County (Natural Resources Conservation Service 2018a).	Unlikely to occur (all). Cave Creek does not contain perennial aquatic habitat. The nearest known occurrence is approximately 14 miles northwest of the Cave Creek Parcel, in the Agua Fria River (SEINet 2018).
Giant reed	*Arundo donax*	TNF	Occurs in moist areas including ditches, stream and riverbanks, and floodplains; prefers well-drained soils with abundant moisture; will tolerate a wide variety of conditions, including high salinity; will tolerate a wide range of soil types from clay to sand; typically occurs below 4,000 feet amsl (White 2013).	Has occurrence records in Cochise, Maricopa, and Navajo Counties (Natural Resources Conservation Service 2018a). Occurs upstream of Tonto National Forest on the Upper Verde, with potential to invade in a large river scouring event (Tonto National Forest 2018).	May occur • Cave Creek If sufficient moisture occurs, as there are occurrence records 3 miles downstream (SEINet 2018). Unlikely to occur • Apache Leap South • Turkey Creek • Tangle Creek • East Clear Creek Sites are at least 30 miles from the nearest known occurrence (SEINet 2018; Tonto National Forest 2018) and Apache Leap South does not contain suitable moist habitat.
Giant salvinia	*Salvinia molesta*	Federal ADA	Prefers warm, fresh water in temperate and subtropical climates (Chambers and Hawkins 2002).	Found in slow-moving water or still-water canals, ponds, rivers, lakes, and reservoirs (Chambers and Hawkins 2002). Occurrence records from the southwest portion of Arizona, in and near the Colorado River (SEINet 2018).	Unlikely to occur (all). All parcels are distant from nearest known location in the Colorado River (SEINet 2018).
Globe chamomile [stinknet]	*Oncosiphon piluliferum*	TNF	Occurs in disturbed areas including waste places, pastures, and along roadsides; typically found below 3,500 feet amsl elevation; this annual is a pioneer species within disturbed sites (White 2013).	Has occurrence records in Maricopa, Pinal, and Yavapai Counties (Natural Resources Conservation Service 2018a). Documented along I-17 north of Phoenix, near Skunk Tank Ridge south of Cave Creek on the Cave Creek Ranger District, at the Cave Creek Ranger Station, at the Sonora Desert National Monument, Pinal City near Superior, along State Route 84 west of Casa Grande, Extension Service Demonstration Garden (east Broadway in Phoenix), on Carefree Highway 4 miles east of I-17, and growing in cultivation at the Desert Botanical Garden and Boyce Thompson Arboretum (Tonto National Forest 2018).	May occur • Cave Creek Occurrence records less than 3 miles south of the site (SEINet 2018). Unlikely to occur • Apache Leap South • Tangle Creek • Turkey Creek • East Clear Creek Known occurrences are more than 10 miles from these sites (SEINet 2018), and these sites do not contain typical disturbed habitats.

Common Name	Scientific Name	Status	Habitat Components (Elevation, Soils, Veg Association, Slope, Aspect, etc.)	Geographical Range in Arizona	Likelihood of Occurrence
Globe-podded hoary cress [whitetop]	*Cardaria draba*	TNF ADA	Occurs in cultivated, disturbed, or degraded moist sites along roadsides or within meadows, grassland, chaparral, woodland, forest, and riparian communities; prefers alkaline to saline soils, but will tolerate a wide variety of soil and moisture conditions; typically found between 3,000 and 8,000 feet amsl (White 2013).	Has occurrence records in Navajo, Santa Cruz, and Yavapai Counties (Natural Resources Conservation Service 2018a). *Cardaria* spp. has been recorded in Prescott, Camp Verde, Flagstaff, and Cottonwood, and on the upper Verde River near Perkinsville; on the Tonto National Forest, occurs on the Pleasant Valley Ranger District (Tonto National Forest 2018).	May occur • Appleton Ranch parcels • East Clear Creek • Turkey Creek Known occurrences nearby (SEINet 2018; Tonto National Forest 2018) and suitable moist habitat may be present. Unlikely to occur • Cave Creek • Tangle Creek Distant from known occurrences (SEINet 2018; Tonto National Forest 2018). Unlikely to occur • Dripping Springs • Apache Leap South Distant from known occurrences (SEINet 2018; Tonto National Forest 2018). Unlikely to occur • San Pedro River Distant from known occurrences (SEINet 2018) and parcel is below usual elevational range.
Hairy white-top	*Cardaria pubescens*	TNF ADA	Occurs in cultivated, disturbed, or degraded moist sites along roadsides or within meadows, grassland, chaparral, woodland, forest, and riparian communities; prefers alkaline to saline soils, but can tolerate a wide range of soils and moisture conditions; typical elevation is 3,000 to 8,000 feet amsl (White 2013).	*Cardaria* spp. has been recorded in Prescott, Camp Verde, Flagstaff, and Cottonwood, and on the upper Verde River near Perkinsville; on the Tonto National Forest, occurs on the Pleasant Valley Ranger District (Tonto National Forest 2018).	May occur • East Clear Creek • Turkey Creek Known occurrences nearby (SEINet 2018; Tonto National Forest 2018) and suitable moist habitat may be present. Unlikely to occur • Cave Creek • Tangle Creek • Appleton Ranch parcels Distant from known occurrences (SEINet 2018; Tonto National Forest 2018) Unlikely to occur • Dripping Springs • Apache Leap South Distant from known occurrences (SEINet 2018; Tonto National Forest 2018) and does not contain disturbed or degraded moist sites: Unlikely to occur • San Pedro River Distant from known occurrences (SEINet 2018) and parcel is below usual elevational range.
Halogeton [saltlover]	*Halogeton glomeratus*	ADA	Occurs in cultivated, disturbed, or degraded sites along roadsides or within grassland or woodland communities; prefers open areas and alkaline and saline soils, generally at elevations ranging from 4,000 to 6,500 feel amsl (White 2013).	Has occurrence records in Apache, Navajo, and Mohave Counties (Natural Resources Conservation Service 2018a).	Unlikely to occur (all). • San Pedro River • Cave Creek • Tangle Creek Distant from known occurrences (SEINet 2018) and below typical elevational range. • Appleton Ranch parcels • Turkey Creek • Dripping Springs • Apache Leap South • East Cave Creek Distant from known occurrences (SEINet 2018)

Common Name	Scientific Name	Status	Habitat Components (Elevation, Soils, Veg Association, Slope, Aspect, etc.)	Geographical Range in Arizona	Likelihood of Occurrence
Hydrilla [waterthyme]	*Hydrilla verticillata*	Federal ADA	Found mainly in freshwater aquatic systems but can tolerate low salinity. Sometimes found in upper reaches of estuaries. Found in shallow water, but in clear water can survive down to 49 feet (Chambers and Hawkins 2002).	Has occurrence records in Maricopa County (Natural Resources Conservation Service 2018a).	Unlikely to occur (all). There are known occurrences in the Phoenix metropolitan area (SEINet 2018), but none in proximity to any parcels.
Iberian starthistle [Iberian knapweed]	*Centaurea iberica*	ADA	Occurs along banks of watercourses and other moist sites, typically below 3,200 feet amsl elevation (White 2013).	No occurrence records in Arizona (Natural Resources Conservation Service 2018a).	Unlikely to occur (all). This species is not known to occur in Arizona.
Japanese brome	*Bromus japonicus*	TNF	Occurs in cultivated, disturbed, or degraded sites along roadsides and within semidesert grassland and wooded communities at elevations ranging from 4,500 to 7,200 feet amsl (White 2013).	Has occurrence records in Apache, Cochise, Coconino, Gila, Greenlee, Maricopa, Pima, and Navajo Counties (Natural Resources Conservation Service 2018a).	Unlikely to occur. • Cave Creek • Tangle Creek • Apache Leap South • Turkey Creek All Tonto National Forest sites are at least 12 miles from a known occurrence (SEINet 2018), all except Turkey Creek occur below typical elevation, and Turkey Creek contains only minor disturbances.
Japanese knotweed	*Polygonum cuspidatum*	TNF	Riparian areas, including along streams and rivers, low-lying areas, utility rights-of-way; it rapidly colonizes scoured areas and can survive severe floods; can tolerate full shade, high temperatures, high salinity, and drought (U.S. Forest Service 2018d).	No occurrence records in Arizona (Natural Resources Conservation Service 2018a),and is not known from Tonto National Forest (Tonto National Forest 2018).	Unlikely to occur as does not occur in Arizona: • Cave Creek • Turkey Creek • Tangle Creek • Apache Leap South
Jointed goatgrass	*Aegilops cylindrica*	TNF ADA	Occurs above 4,000 feet amsl, occurs in disturbed areas. Occurs in dry sites in grassland or wooded communities and roadsides at elevations ranging from 5,300 to 7,000 feet amsl (White 2013).	Has occurrence records in Apache, Cochise, Coconino, Navajo, and Yavapai Counties (Natural Resources Conservation Service 2018a). Occurs along State Route 87 from Payson to Strawberry, and in the Young area (Tonto National Forest 2018).	May occur • East Clear Creek Site may contain suitable habitat and is situated near State Route 87. Unlikely to occur • Cave Creek • Tangle Creek • San Pedro River Distant from known occurrences (SEINet 2018; Tonto National Forest 2018) and below usual elevational range. Unlikely to occur • Turkey Creek • Apache Leap South • Dripping Springs • Appleton Ranch parcels Distant from known occurrences (SEINet 2018; Tonto National Forest 2018).
Karoo bush [African sheepbush]	*Pentzia incana*	TNF	Occurs in dry, disturbed sites including waste places, pastures, and along roadsides within desert, semidesert, grassland, chaparral oak scrub and pinyon-juniper woodland communities typically below 5,300 feet amsl elevation (White 2013).	Occurrence records in Graham County (Natural Resources Conservation Service 2018a). Has been documented at one site on Tonto National Forest, north of the Oak Flat Campground on the Globe Ranger District (Tonto National Forest 2018).	Unlikely to occur • Cave Creek • Tangle Creek • Oak Flat Known occurrences are more than 30 miles (SEINet 2018). Unlikely to occur • Apache Leap South Although the Oak Flat occurrence is within 4 miles of Apache Leap South (SEINet 2018; Tonto National Forest 2018), this parcel does not contain suitable disturbed habitat for this species.

Common Name	Scientific Name	Status	Habitat Components (Elevation, Soils, Veg Association, Slope, Aspect, etc.)	Geographical Range in Arizona	Likelihood of Occurrence
Kochia	*Kochia scoparia [Bassia scoparia]*	TNF	Occurs in cultivated, disturbed, or degraded sites along roadsides and within grassland and woodland communities in well-drained, uncompacted soil, below 8,500 feet amsl; thrives in warm, low rainfall environments; burns easily owing to plant structure (White 2013).	Has occurrence records in Apache, Cochise, Coconino, Navajo, and Pima Counties (Natural Resources Conservation Service 2018a).	May occur • Cave Creek Occurrence record approximately 3 miles south (SEINet 2018). Unlikely to occur • Tangle Creek • Turkey Creek • Apache Leap South Sites are minimally disturbed and are at least 10 miles from a known occurrence (SEINet 2018).
Leafy spurge	*Euphorbia esula*	TNF ADA	Occurs in cultivated, disturbed, or degraded sites along roadsides and within fields, pastures, rangeland, and riparian communities, typically between 4,600 and 9,500 feet amsl (White 2013).	Has occurrence records in Coconino County (Natural Resources Conservation Service 2018a). Has been documented in the Coconino National Forest but not on the Tonto National Forest (Tonto National Forest 2018).	Unlikely to occur (all). All are more than 25 miles from nearest known occurrence (SEINet 2018; Tonto National Forest 2018).
Lehmann's lovegrass	*Eragrostis lehmanniana*	TNF	Occurs in cultivated, disturbed, and degraded sites on sandy flats and on calcareous slopes within desert grassland, semidesert grassland, and woodland communities and roadsides, generally between 3,500 and 4,000 feet amsl elevation (White 2013).	Has occurrence records in Cochise, Coconino, Graham, Maricopa, and Pima Counties (Natural Resources Conservation Service 2018a). Within Tonto National Forest, seeded extensively along highways, power line corridors, and after fires (Tonto National Forest 2018).	May occur • Apache Leap South • Turkey Creek • Cave Creek • Tangle Creek Although several parcels are below the typical elevation, there are occurrence records within 5 miles (SEINet 2018) and suitable habitat may be present.
Lens podded hoary cress	*Cardaria chalepensis*	ADA	Occurs in cultivated, disturbed, or degraded moist sites along roadsides and within meadows, grassland, chaparral, woodland, forest, and riparian communities; prefers alkaline to saline soils but can tolerate a wide variety of soils and moisture conditions; elevations typically range from 3,300 to 6,000 feet amsl (White 2013).	No occurrence records in Arizona (Natural Resources Conservation Service 2018a). One isolated record from 1992 occurs more than 30 miles east of the East Clear Creek Parcel (SEINet 2018).	Unlikely to occur (all). No current records from Arizona.
Lightningweed	*Drymaria arenarioides*	Federal ADA	Prefers dry areas, acidic soils, hills and plains, and stressed rangelands (Scher et al. 2015). It is well adapted to soils and climates within the *Bouteloua-Aristada* type (CABI 2018).	Invades rangeland, displacing desired vegetation and his highly toxic to livestock. This species has not been documented in the U.S., but is spreading northward, reportedly to within 1 mile of New Mexico (Scher et al. 2015). No records in the United States (Natural Resources Conservation Service 2018a).	Unlikely to occur (all). This species is not known to occur in the United States.
Malta starthistle	*Centaurea melitensis*	TNF	Occurs in cultivated, disturbed, or degraded sites along roadways and within grassland and woodland communities at elevations below 7,200 feet amsl; is a competitive and aggressive plant (White 2013).	Has occurrence records in Apache, Cochise, Graham, Maricopa, Mohave, Pima, Pinal, and Yavapai Counties (Natural Resources Conservation Service 2018a). Widespread on Tonto National Forest at low elevations below 3,000 feet (Tonto National Forest 2018).	May occur • Apache Leap South • Cave Creek • Turkey Creek • Tangle Creek Occurrence records are common on Tonto National Forest (SEINet 2018), not all of which are along roadways or below 3,000 feet amsl elevation.
Mediterranean grass	*Schismus barbatus*	TNF	Occurs in roadways and cultivated, disturbed, or degraded sites along roadways and in desert and semidesert grassland communities, generally below 5,000 feet amsl elevation (White 2013).	All Arizona counties except Apache, Cochise, Graham, Greenlee, and Navajo (Natural Resources Conservation Service 2018a).	May occur • Apache Leap South • Cave Creek Within 5 miles of the nearest known occurrence (SEINet 2018) and occur within the Sonoran desertscrub biome. Unlikely to occur • Turkey Creek • Tangle Creek These sites are at higher elevation than is typical for this species, and neither site contains desert or semidesert grassland communities; known occurrences are also more than 10 miles from these sites (SEINet 2018).

Common Name	Scientific Name	Status	Habitat Components (Elevation, Soils, Veg Association, Slope, Aspect, etc.)	Geographical Range in Arizona	Likelihood of Occurrence
Mediterranean sage	*Salvia aethiopis*	TNF	Occurs in roadways and cultivated, disturbed, or degraded sites along roadways and within meadows, grassland, woodland, and riparian communities; prefers well-drained soil; occurs at elevations typically below 8,500 feet amsl (White 2013).	Has occurrence records in Coconino and Yavapai Counties (Natural Resources Conservation Service 2018a).	Unlikely to occur • Apache Leap South • Tangle Creek • Turkey Creek • Cave Creek These sites are all at least 50 miles away from the nearest known occurrence (SEINet 2018).
Mexican paloverde	*Parkinsonia aculeata*	TNF	On the Tonto National Forest, infestation occurred from a single ornamental planting in Camp Creek area; typically invades waste areas at low elevations (Tonto National Forest 2018). Invasive on degraded rangelands; tolerant of drought, waterlogging, and saline conditions (CABI 2018).	Has occurrence records in Gila, Graham Maricopa, Pima, Pinal, Santa Cruz, and Yuma Counties where it is a native species (Natural Resources Conservation Service 2018a). On Tonto National Forest, a 2-acre infestation occurs from areas burned in the Cave Creek Complex fire near Camp Creek (Tonto National Forest 2018).	May occur • Cave Creek This parcel is 3 miles north of a known recent occurrence (SEINet 2018). Unlikely to occur • Apache Leap South • Tangle Creek • Turkey Creek These sites are distant from known occurrences (SEINet 2018; Tonto National Forest 2018).
Morning-glory	*Ipomeoea* spp. [all except *I. carnea* and *I. aborescens*] *I. triloba* is a "restricted pest" according to ADA (see below)	ADA	Suitable habitat depends on species. For example *I. hederacea* and *I. purpurea* occur in disturbed areas, *I. tenuiloba* occurs in pinyon-juniper woodlands (SEINet 2018).	There are 69 species of *Ipomoea*, including native and introduced species, in the PLANTS database, 15 of which have occurrence records in Arizona (Natural Resources Conservation Service 2018a).	May occur (all). This genus is widespread in Arizona, and has occurrence records within 5 miles of each parcel (SEINet 2018). Disturbed areas occur within each parcel, and most parcels contain drainages or roadsides, which may contain suitable microclimates for many species within this genus.
Musk thistle	*Carduus nutans*	TNF	Grows from sea level up to 8,000 feet amsl in neutral to acidic soils; invades open areas (e.g., meadows or prairies) and spreads rapidly in areas of natural disturbance including landslides and flooding; does not grow well in conditions that are excessively wet, dry, or shady (U.S. Forest Service 2018d). Typically occurs between 4,200 and 8,100 feet amsl (White 2013).	Has occurrence records in Apache and Navajo Counties (Natural Resources Conservation Service 2018a). Grows on Coconino National Forest; found on the Tonto National Forest north and east of Payson in the area of the 1990 Dude Fire (Tonto National Forest 2018).	Unlikely to occur • Cave Creek • Tangle Creek • Turkey Creek • Apache Leap South There is no meadow or prairie habitat on any of the sites. Known occurrences are distant from the sites (SEINet 2018).
Oleander	*Nerium oleander*	TNF	On the Tonto National Forest, has naturalized in Camp Creek and near Boyce Thompson Arboretum; in California has been found in floodplain and riparian zones (Tonto National Forest 2018).	Has occurrence records in Maricopa County (Natural Resources Conservation Service 2018a). On Tonto National Forest, near Camp Creek and Boyce Thompson Arboretum (Tonto National Forest 2018).	Unlikely to occur • Cave Creek • Tangle Creek • Turkey Creek • Apache Leap South This species is only known from two locations on Tonto National Forest (SEINet 2018; Tonto National Forest 2018).
Onionweed	*Asphodelus fistulosus*	TNF Federal	In the Sonoran Desert region, it seems to do best at altitudes above the desert floor that receive moderate rainfall during winter. Tends to invade disturbed land leaving its potential threat to natural areas unclear (Animal and Plant Health Inspection Service 2019). Elevation is 2,000–4,500+ feet amsl (Animal and Plant Health Inspection Service 2019). Occurs in sandy or rocky disturbed sites, including roadsides, railroad rights-of-way, pastures, and waste places; typically occurs below 4,600 feet amsl; drought resistant (White 2013).	Known in the five southeastern counties (Pima, Pinal, Santa Cruz, Cochise, and Greenlee) and in an area near Sedona in Yavapai County (Animal and Plant Health Inspection Service 2019). Not known to occur on Tonto National Forest (Tonto National Forest 2018).	May occur • Appleton Ranch parcels Disturbance occurs, and there is an occurrence record less than 1 mile south of the northeast parcel (SEINet 2018). Unlikely to occur • San Pedro River • Dripping Springs • East Clear Creek Distant from known occurrences (SEINet 2018; Tonto National Forest 2018).
Oxeye daisy	*Leucanthemum vulgare*	TNF	Occurs in cultivated, disturbed, or degraded sites on well-drained but moist soils along roadsides and within meadows, grassland, woodland, and forest communities at elevations from 5,000 to 9,500 feet amsl (White 2013).	Has occurrence records in Apache, Coconino, Gila, and Navajo Counties (Natural Resources Conservation Service 2018a). Identified growing near Canyon Creek, Pleasant Valley Ranger District, Tonto National Forest; occurs in Flagstaff and Kachina Village, south of Flagstaff (Tonto National Forest 2018).	Unlikely to occur (all Tonto National Forest parcels). All Tonto National Forest Parcels are at least 20 miles away from nearest known occurrence records (SEINet 2018). Only Turkey Creek is within the typical elevational range.

Common Name	Scientific Name	Status	Habitat Components (Elevation, Soils, Veg Association, Slope, Aspect, etc.)	Geographical Range in Arizona	Likelihood of Occurrence
Perennial sowthistle	*Sonchus arvensis*	ADA	Occurs in cultivated, disturbed, or degraded moist sites along roadsides and within grassland, woodland, and riparian communities; can be found in non-compacted, fine, rich, slightly alkaline to neutral soils at elevations ranging from 5,000 to 6,000 feet amsl (White 2013).	No occurrence records in Arizona (Natural Resources Conservation Service 2018a).	Unlikely to occur (all). This species is not known to occur in Arizona.
Periwinkle	*Vinca major*	TNF	Occurs in highly disturbed areas including old homesteads, roadsides, and waste places; also occurs in riparian areas, forests, and grasslands; typically occurs below 7,500 feet amsl elevation (White 2013).	Has occurrence records in Cochise, Coconino, Maricopa, Pima, Santa Cruz, and Yavapai Counties (Natural Resources Conservation Service 2018a). Occurs on Tonto National Forest adjacent to private lands (e.g., Grantham Homestead off Highway 288) (Tonto National Forest 2018).	Unlikely to occur (all Tonto National Forest parcels). No Tonto National Forest parcel contains highly disturbed areas, and all Tonto National Forest parcels except Apache Leap South are at least 5 miles from known occurrences (SEINet 2018; Tonto National Forest 2018).
Plumeless thistle	*Carduus acanthoides*	TNF ADA	Occurs in sites that are dry and well-drained; occurs in cultivated, disturbed, or degraded sites within meadows, grassland, chaparral, woodland, forest, and riparian communities or roadsides at elevations generally ranging from 4,200 to 8,800 feet amsl (White 2013).	While the PLANTS database shows no occurrence records in Arizona (Natural Resources Conservation Service 2018a), other sources indicate occurrence records in Petrified Forest National Park (Tonto National Forest 2018). SEINet (2018) shows no occurrences in Arizona.	Unlikely to occur (all). All parcels are distant to potential occurrences in Petrified Forest National Park.
Puna grass	*Stipa brachychaeta*	ADA	Disturbed soils along roadsides; streambanks, and waste places (Agriculture Victoria 2017).	No occurrence records in Arizona (Natural Resources Conservation Service 2018a).	Unlikely to occur (all). This species is not known to occur in Arizona.
Puncturevine	*Tribulus terrestris*	ADA	Occurs in cultivated, disturbed, or degraded moist sites along roadsides and within grassland, woodland, and riparian communities; prefers dry, sandy soils but tolerates most soil types; found at elevations below 7,000 feet amsl (White 2013).	Has occurrence records in all Arizona counties (Natural Resources Conservation Service 2018a).	May occur • San Pedro River • Cave Creek Sites contain disturbance or roads and are near to known occurrences (SEINet 2018). Unlikely to occur • Appleton Ranch parcels • Tangle Creek Sites are distant from known occurrences (SEINet 2018). Unlikely to occur • Dripping springs • Turkey Creek • Apache Leap South • East Clear Creek Sites are distant from known occurrences (SEINet 2018) and have limited disturbance.
Purple loosestrife	*Lythrum salicaria*	TNF ADA	Occurs in cultivated, disturbed, or degraded sites in perennial and seasonal wetlands; occurs along marsh and pond edges, streambanks, canals, and ditches at elevations generally from 4,500–6,800 feet amsl (White 2013).	While the PLANTS database and SEINet show no occurrence records in Arizona (Natural Resources Conservation Service 2018a; SEINet 2018), other sources indicate occurrence records in on the Apache-Sitgreaves National Forests (Tonto National Forest 2018).	Unlikely to occur (all). All parcels are distant to potential occurrences in Apache-Sitgreaves National Forests.
Purple starthistle	*Centaurea calcitrapa*	ADA	Occurs cultivated, disturbed, or degraded sites with fertile soil; occurs in meadows, grassland, woodland, and forest communities and along roadsides at elevations typically ranging from 3,300 to 8,000 feet amsl; germination occurs under a broad range of conditions with fewer viable seeds produced in dry years; plants seldom persist under shady conditions (White 2013).	Has occurrence records in Yuma County (Natural Resources Conservation Service 2018a).	Unlikely to occur (all). All parcels are distant to known occurrence records (SEINet 2018) and do not occur in Yuma County.
Pyracantha	*Pyracantha* sp.	TNF	Not a common invasive in the desert Southwest; on the Tonto National Forest, occurred along Cave Creek (Tonto National Forest 2018). Drought resistant, common landscape plant; prefers dry soil and full sun (Dierking 1998).	Has occurrence records in Maricopa County (Natural Resources Conservation Service 2018a). On Tonto National Forest, occurred along Cave Creek (Tonto National Forest 2018).	Unlikely to occur (all Tonto National Forest parcels). All Tonto National Forest parcels are distant from known occurrences (SEINet 2018; Tonto National Forest 2018) and this species is not a common invasive.

Common Name	Scientific Name	Status	Habitat Components (Elevation, Soils, Veg Association, Slope, Aspect, etc.)	Geographical Range in Arizona	Likelihood of Occurrence
Quackgrass	*Elymus repens*	TNF ADA	Occurs in disturbed or degraded sites within grasslands, woodlands, forest communities, or along roadsides at elevations between 6,700 and 8,500 feet amsl; is extremely drought tolerant (White 2013).	Has occurrence records in Coconino, Gila, and Navajo Counties (Natural Resources Conservation Service 2018a). Documented near Flagstaff, in Grand Canyon National Park, and on one site in Tonto National Forest, on Pleasant Valley Ranger District (Tonto National Forest 2018).	May occur • East Clear Creek Occurs near known occurrence (SEINet 2018) and is close to the usual elevational range. Unlikely to occur • San Pedro River • Dripping Springs • Appleton Ranch • Turkey Creek • Apache Leap • Cave Creek • Tangle Creek Distant to known recent occurrences (SEINet 2018; Tonto National Forest 2018) and below typical elevational range.
Red brome	*Bromus rubens*	TNF	Occurs in cultivated, disturbed, or degraded sites along roadsides and in meadows, grassland, chaparral, woodland, and riparian communities, generally below 7,200 feet amsl elevation (White 2013). Red brome cannot withstand temperatures below freezing (Tonto National Forest 2018).	Has occurrence records in all Arizona counties, except Cochise, Greenlee, La Paz, Navajo, Santa Cruz, and Yuma (Natural Resources Conservation Service 2018a). Widespread on Tonto National Forest (Tonto National Forest 2018).	May occur (all Tonto National Forest parcels). This species is widespread, occurs in a wide variety of habitats, and occurs within 2.5 miles of Cave Creek, Tangle Creek, and Apache Leap South, and approximately 6.5 miles of Turkey Creek (SEINet 2018).
Rescuegrass	*Bromus catharticus*	TNF	Occurs in cultivated, disturbed, or degraded soils along roadsides or within desert or semidesert communities generally below 4,500 feet amsl elevation; can tolerate both cold temperatures and drought conditions (White 2013).	Has occurrence records in all Arizona counties except Pinal and Greenlee (Natural Resources Conservation Service 2018a). Likely grows on Tonto National Forest; occurs at Montezuma Castle National Monument and in the Tucson Mountains (Tonto National Forest 2018).	May occur • Cave Creek Unlikely to occur • Apache Leap South Is an occurrence within 3 miles of the (SEINet 2018) but disturbed areas do not occur. Unlikely to occur • Turkey Creek • Tangle Creek Sites do not contain desert or semidesert communities and are more than 15 miles from the nearest occurrence record (SEINet 2018).
Ripgut brome	*Bromus diandrus*	TNF	Occurs in cultivated, disturbed, or degraded sites along roadsides and within desert and semidesert communities, at elevations typically ranging from 3,200 to 4,600 feet amsl (White 2013).	Has occurrence records in Cochise, Coconino, Graham, Maricopa, Mohave, Pima, Pinal, and Yavapai Counties (Natural Resources Conservation Service 2018a). Occurs on National Monuments near Tonto National Forest, including Tuzigoot, Montezuma Castle, and Tonto National Monuments, and at the Hassayampa River Preserve; also occurs on the Verde where Highway 260 crosses, near the town of Strawberry, in the area of the Willow Fire of 2004 west of Rye, and at Sycamore Creek along the Beeline Highway (Tonto National Forest 2018).	May occur • Cave Creek Although below typical elevational range, it contains desert or semidesert conditions with some road disturbance, and occurs within 3 miles of the nearest occurrence record (SEINet 2018). Unlikely to occur • Apache Leap South There is an occurrence within 3 miles (SEINet 2018) but disturbed areas do not occur. Unlikely to occur • Turkey Creek • Tangle Creek Sites do not contain desert or semi-desert communities and are more than 6 miles from the nearest occurrence record (SEINet 2018).
Rush skeleton weed	*Chondrilla juncea*	TNF ADA	Occurs in cultivated, disturbed, or degraded sites along roadsides and within grassland and woodland communities; prefers well-drained sandy or gravely soils below 5,500 feet amsl (White 2013).	No occurrence records in Arizona (Natural Resources Conservation Service 2018a).	Unlikely to occur (all). This species is not known to occur in Arizona.

Common Name	Scientific Name	Status	Habitat Components (Elevation, Soils, Veg Association, Slope, Aspect, etc.)	Geographical Range in Arizona	Likelihood of Occurrence
Russian knapweed	*Acroptilon repens*	TNF ADA	Occurs in cultivated, disturbed, or degraded sites along roadsides and within meadows, grassland, and riparian communities at elevations ranging from 3,000 to 8,000 feet amsl; found in variety of soil types; is a very competitive and aggressive species (White 2013).	Has occurrence records in Apache, Cochise, Greenlee, Maricopa, Navajo, Pima, and Yavapai Counties (Natural Resources Conservation Service 2018a). Documented in vicinity of Gordon Canyon on State Route 260 and at Shumway Millsite on Payson Ranger District, south of Payson (Tonto National Forest 2018).	May occur • Turkey Creek • East Clear Creek Sites are within the usual elevational range, contain some disturbance, and are in the vicinity of known occurrences (SEINet 2018; Tonto National Forest 2018). Unlikely to occur • Cave Creek • Tangle Creek • Apache Leap • Dripping Springs Sites are more than 20 miles from nearest known occurrence (SEINet 2018) and have minimal disturbance. Unlikely to occur • Appleton Ranch parcels • San Pedro River Nearest known infestation is at least 20 miles (SEINet 2018).
Russian olive	*Elaeagnus angustifolia*	TNF	Seedlings tolerant of shade, thrives in a variety of soil and moisture conditions, including bare mineral substrates; found in open areas, grasslands, streambanks, lakeshores, roadsides, and urban areas (U.S. Forest Service 2018d). Typically occurs at elevations ranging from 4,000 to 7,500 feet amsl; can dominate riparian vegetation where overstory cottonwood (*Populus* spp.) have died (White 2013).	Has occurrence records in Apache, Coconino, and Navajo Counties (Natural Resources Conservation Service 2018a).	Unlikely to occur (all Tonto National Forest parcels). Distant from known occurrences (SEINet 2018). In addition, Tangle Creek and Cave Creek are below the typical elevational range, and Apache Leap South does not contain suitable habitat.
Russian thistle	*Salsola kali* and *S. tragus*	TNF	*Salsola* spp. occurs on cultivated, disturbed, or degraded sites along roadsides and within grassland and woodland communities; can occur on any type of well-drained uncompacted soil, but is most frequently found in alkaline or saline soil below 8,500 feet amsl; burns easily owing to plant structure (White 2013).	*Salsola* spp. has occurrence records in all Arizona counties (Natural Resources Conservation Service 2018a).	May occur • Cave Creek • Tangle Creek • Turkey Creek • Apache Leap South This species is widespread in the vicinity of the parcels (SEINet 2018).
Saltcedar	*Tamarix ramosissima*	TNF	*Tamarix* spp. occur in moist meadow and riparian communities, in drainage washes of both natural and artificial water bodies, and in other areas where seedlings can be exposed to extended periods of saturated soil conditions; can grow on saline soils with up to 15,000 ppm soluble salt; occurs below 7,500 feet amsl elevation (White 2013).	Has occurrence records in Mohave and Pima Counties (Natural Resources Conservation Service 2018a). On Tonto National Forest, saltcedar occurs along the Verde River and its tributaries; along much of the Salt River; and along Salt and Verde River reservoirs (Tonto National Forest 2018).	May occur • Cave Creek • Tangle Creek • Turkey Creek This species occurs approximately 3 miles south of the Cave Creek (SEINet 2018). May occur at Tangle Creek and Turkey Creek, if sufficient water occurs. Unlikely to occur • Apache Leap South Lacks riparian habitat or roadsides.
Scotch thistle	*Onopordum acanthium*	TNF ADA	Occurs in cultivated, disturbed, or degraded moist sites within meadows, grassland, woodland, and riparian communities, typically below 7,500 feet amsl; can germinate year-round (White 2013).	Has occurrence records in Apache, Navajo, and Yavapai Counties (Natural Resources Conservation Service 2018a). Common in Four Corners area, the Arizona Strip, and along Interstate system near Flagstaff; observed on Tonto National Forest growing in Strawberry at State Route 87 bridge (Tonto National Forest 2018).	May occur • East Clear Creek. This site is in the vicinity of known occurrences (SEINet 2018; Tonto National Forest 2018) and occurs along State Route 87, and contains riparian areas with some disturbance. Unlikely to occur. • Cave Creek • Tangle Creek • Turkey Creek • San Pedro River • Appleton Ranch • Apache Leap South • Dripping Springs Sites are distant to known occurrences of this species (SEINet 2018; Tonto National Forest 2018), and some parcels contain minimal disturbance.

Common Name	Scientific Name	Status	Habitat Components (Elevation, Soils, Veg Association, Slope, Aspect, etc.)	Geographical Range in Arizona	Likelihood of Occurrence
Serrated tussock	*Nassella trichotoma*	Federal ADA	Grows in a wide range of climatic conditions and soil types, being able to tolerate floods, drought, exposure to salt and repeated frost (CABI 2018).	No occurrence records in Arizona (Natural Resources Conservation Service 2018a).	Unlikely to occur (all). This species is not known to occur in Arizona.
Siberian elm	*Ulmus pumila*	TNF	In Arizona, this species is found in forested areas and high elevations (U.S. Forest Service 2018d). Occurs in cultivated, disturbed, or degraded sites along roadsides and within meadow, grassland, woodland, and riparian communities in well-drained soils, typically below 8,100 feet amsl elevation (White 2013).	Has occurrence records in Apache, Maricopa, and Navajo Counties (Natural Resources Conservation Service 2018a). Isolated records from Coconino National Forest east of Flagstaff and in Verde River/Lynx Lake/Thumb Butte areas of Prescott National Forest (Tonto National Forest 2018).	Unlikely to occur (all Tonto National Forest parcels). Nearest known occurrences are at least 20 miles from parcels (SEINet 2018).
Sicilian starthistle	*Centaurea sulphurea*	ADA	Occurs in cultivated, disturbed, or degraded sites along roadsides and within grassland and woodland communities at elevations typically below 3,300 feet amsl (White 2013).	No occurrence records in Arizona (Natural Resources Conservation Service 2018a).	Unlikely to occur (all). This species is not known to occur in Arizona.
Smallflower tamarisk	*Tamarix parviflora*	TNF	Riparian habitats, along permanent or intermittent streams, lakes, and reservoirs; can grow in a wide variety of soils, and can tolerate salinity (CABI 2018).	Has occurrence records in Arizona but not county-specific records (Natural Resources Conservation Service 2018a). On Tonto National Forest, *Tamarix* spp. occur along the Verde River and its tributaries; along much of the Salt River; and along Salt and Verde River reservoirs (Tonto National Forest 2018).	Unlikely to occur (all Tonto National Forest parcels). This species has no occurrence records in the vicinity of the parcels (SEINet 2018; Tonto National Forest 2018).
Southern sandbur	*Cenchrus echinatus*	TNF ADA	Occurs in cultivated, disturbed, or degraded sites that contain sandy or gravelly conditions; is an aggressive colonizer with rapid growth under moist conditions; usually occurs at elevations between 3,500 to 4,500 feet amsl (White 2013).	Has occurrence records in Cochise, Maricopa, Pima, and Yuma Counties (Natural Resources Conservation Service 2018a). Occurs east of Tonto National Forest on the Fort Apache Reservation along the right-of-way for Highway 60 east; occurs on Tonto National Forest on right-of-way of State Route 188, a few miles north of Globe, Arizona (Tonto National Forest 2018).	Unlikely to occur • Dripping Springs • Appleton Ranch parcels Distant from known occurrences (SEINet 2018). Unlikely to occur. • Cave Creek • Tangle Creek • East Clear Creek • Turkey Creek • Apache Leap South • San Pedro River Distant from known occurrences (SEINet 2018); and outside the typical elevational range.
Spotted knapweed	*Centaurea biebersteinii*	TNF	Found at elevations from sea level to 10,000 feet amsl in areas receiving 8 to 80 inches of rain a year; prefers well-drained light-textured soils that receive summer rain in a wide variety of open forest, prairie, and rangelands; disturbance promotes rapid establishment and spread (U.S. Forest Service 2018d).	While the PLANTS database shows occurrence records only in Santa Cruz County (Natural Resources Conservation Service 2018a), other sources indicate occurrence records along Highways 89A and 179 in Sedona, on Northern Arizona University campus, along Lake Mary Road and in the vicinity of Prescott; also north of Grand Canyon in the Arizona Strip, and north of Tonto National Forest above the Mogollon Rim; with an unconfirmed report on the Pleasant Valley Ranger District (Tonto National Forest 2018).	Unlikely to occur (all Tonto National Forest parcels). All Tonto National Forest parcels are distant from known occurrences of this species (SEINet 2018; Tonto National Forest 2018).
Squarrose knapweed	*Centaurea squarrosa*	ADA	Found on cultivated, disturbed, or degraded rangelands and roadsides, typically below 8,000 feet amsl elevation; is an aggressive, competitive plant; germination can occur under a broad range of environmental conditions (White 2013).	No occurrence records in Arizona (Natural Resources Conservation Service 2018a).	Unlikely to occur (all). This species is not known to occur in Arizona.
Sulfur cinquefoil	*Potentilla recta*	TNF	Associated with roadsides, disturbed areas, abandoned agricultural fields, and waste areas within grasslands, shrublands, and open-canopy forests; intolerant of complete shade (Zouhar 2003).	While the USDA PLANTS database shows no occurrence records in Arizona, other sources indicate occurrence records along the Rio de Flag and on the Lake Mary Road on Coconino National Forest (Tonto National Forest 2018).	Unlikely to occur (all Tonto National Forest parcels). The nearest known occurrences are more than 30 miles from the parcels (SEINet 2018).
Swamp morning-glory	*Ipomoea aquatica*	Federal ADA	Occurs in moist, marshy, or inundated localities, in shallow pools, ditches, or wet rice fields at elevations between sea level and 3,200 feet amsl (CABI 2018).	No occurrence records in Arizona (Natural Resources Conservation Service 2018a).	Unlikely to occur (all). This species is not known to occur in Arizona.

Common Name	Scientific Name	Status	Habitat Components (Elevation, Soils, Veg Association, Slope, Aspect, etc.)	Geographical Range in Arizona	Likelihood of Occurrence
Sweet resinbush	*Euryops subcarnosus*	TNF	In Arizona, occurs in semiarid grassland, desert grassland, desert shrub, and desert scrub communities below the Mogollon Rim (White 2013).	Has occurrence records in Graham, Pima, and Yavapai Counties (Natural Resources Conservation Service 2018a). Occurs on Fry Mesa south of Safford, on the Santa Rita Experimental Range, and several small patches south of the Globe Ranger Station; west of Highway 188 in Tonto Basin, north of Highway 60, north of the Miami cemetery; and east of cemetery and 2 miles down Bloody Tanks Wash toward Miami (Tonto National Forest 2018).	May occur • Apache Leap South • Tangle Creek • Cave Creek The sites are in the vicinity of known occurrences (Tonto National Forest 2018) and contain some desertscrub or semidesert grassland biotic communities. Unlikely to occur • Turkey Creek Does not contain suitable habitat.
Tansy ragwort [stinking willie]	*Senecio jacobaea*	ADA	Occurs in cultivated, disturbed, or degraded moist sites along roadsides or within meadows, grassland, woodland, and riparian communities; prefers light, well-drained soils at elevations typically below 4,900 feet amsl; this aggressive species is highly poisonous to livestock (White 2013).	No occurrence records in Arizona (Natural Resources Conservation Service 2018a).	Unlikely to occur (all). This species is not known to occur in Arizona.
Texas blueweed	*Helianthus ciliaris*	ADA	Occurs in cultivated, disturbed, or degraded moist open sites along roadsides and within meadows, grassland, woodland, forest, and riparian communities; prefers alkaline or saline soils at elevations ranging from 3,000 to 8,500 feet amsl; thrives in heavily disturbed and cultivated areas (White 2013).	Has occurrence records in Cochise, Gila, Graham, and Pinal Counties (Natural Resources Conservation Service 2018a).	Unlikely to occur (all). All sites are at least 10 miles away from nearest known occurrence (SEINet 2018) and no site contains heavily disturbed areas except San Pedro River parcel, which is below the typical elevational range for this species.
Three-lobed morning-glory	*Ipomoea triloba*	ADA	Occurs in cultivated fields, sandy ground, and grassy swamp margins on hedges, in thickets; low to middle elevations (CABI 2018).	The PLANTS database shows no occurrence records in Arizona (Natural Resources Conservation Service 2018a). SEINet (2018) has two records from Arizona, in 1930.	Unlikely to occur (all). This species has no recent records in Arizona.
Torpedo grass	*Panicum repens*	ADA	Occurs in wet places, along the edges of rivers, irrigation channels, and lakes, but does not tolerate long-term submergence; can occur in a variety of soils, sandy to heavy (CABI 2018).	No occurrence records in Arizona (Natural Resources Conservation Service 2018a).	Unlikely to occur (all). This species is not known to occur in Arizona.
Tree of heaven	*Ailanthus altissima*	TNF	Widely distributed in fields, roadsides, fencerows, woodland edges, and forest openings (U.S. Forest Service 2018d). Generally, occurs below 6,200 feet amsl (White 2013).	Has occurrence records in Cochise, Coconino Gila, Greenlee, Maricopa, Pima, Pinal, Santa Cruz, and Yavapai Counties (Natural Resources Conservation Service 2018a). Occurrences around Cottonwood, Camp Verde, and Jerome; on Coronado National Forest lands; in Tonto National Forest on Verde River near Childs; in Superior and Globe and on National Forest lands nearby; near confluence of Pinal Creek and Salt River; and Payson (Tonto National Forest 2018).	Unlikely to occur (all Tonto National Forest parcels). These parcels are distant from known occurrences (SEINet 2018; Tonto National Forest 2018) and do not contain suitable open, disturbed habitat.
Tropical soda apple	*Solanum viarum*	Federal ADA	Occurs in areas that have been frequented by animals or that have received natural materials contaminated by seed, including pasturelands, roadsides, or cattle yards (U.S. Forest Service 2018d).	No occurrence records in Arizona (Natural Resources Conservation Service 2018a).	Unlikely to occur (all). This species is not known to occur in Arizona.
Water-chestnut	*Trapa natans*	ADA	Prefers full sun, and low-energy, nutrient-rich waters; prefers slightly acidic water (CABI 2018).	No occurrence records in Arizona (Natural Resources Conservation Service 2018a).	Unlikely to occur (all). This species is not known to occur in Arizona.
Weeping lovegrass	*Eragrostis curvula*	TNF	Occurs in cultivated, disturbed, or degraded areas along roadsides or within meadows, grasslands, and at the margins of chaparral, woodland, and forest communities, generally at elevations between 6,000 and 8,000 feet amsl; this species has high potential for establishment on burned sites (White 2013).	Has occurrence records in Cochise, Coconino, Gila, Graham, Maricopa, Pima, and Yavapai Counties (Natural Resources Conservation Service 2018a). Within Tonto National Forest, seeded extensively along highways, power line corridors, and after fires; seeded in Pinal Mountains after a fire (Tonto National Forest 2018).	Unlikely to occur (all Tonto National Forest parcels). None of the parcels contain meadow, grassland, or roadside habitat, and none are above the 6,000 feet amsl elevation typical of this species.
White bietou	*Dimorphotheca cuneata*	TNF	On the Tonto National Forest, occurs in yards and canyons between Six Shooter Canyon and National Forest lands to the west; no other records of this species being invasive in the United States (Tonto National Forest 2018).	Occurs in an approximately 40-acre patch on the Tonto National Forest between Six Shooter Canyon and National Forest land to the west (Tonto National Forest 2018).	Unlikely to occur (all Tonto National Forest parcels). The only known infestation of this species (SEINet 2018; Tonto National Forest 2018) is distant from all Tonto National Forest parcels.
Wild mustard	*Sinapis arvensis*	TNF	Occurs in dry, disturbed sites, including waste places, pastures, roadsides, and railroad rights-of-way, generally below 6,000 feet amsl elevation (White 2013).	Has occurrence records in Gila, Maricopa, Pima, and Pinal Counties (Natural Resources Conservation Service 2018a). Occurs along State Route 188 from Punkin Center to Roosevelt, on private lands; is common on Agua Fria National Monument, west of Perry Mesa tobosa grassland in Cave Creek Ranger District (Tonto National Forest 2018).	Unlikely to occur (all Tonto National Forest parcels). The known occurrences of this species (SEINet 2018; Tonto National Forest 2018) are distant from all Tonto National Forest parcels.

Common Name	Scientific Name	Status	Habitat Components (Elevation, Soils, Veg Association, Slope, Aspect, etc.)	Geographical Range in Arizona	Likelihood of Occurrence
Wild oats	*Avena fatua*	TNF	Occurs in cultivated, disturbed, or degraded areas along roadsides and within desert, semidesert grasslands, and woodland communities, typically at elevations between 2,500 and 7,200 feet amsl (White 2013).	Has occurrence records in all Arizona counties except Graham, Greenlee, La Paz, Navajo, Santa Cruz, and Yuma (Natural Resources Conservation Service 2018a). Found along most highways in Tonto National Forest (Tonto National Forest 2018).	May occur (all Tonto National Forest parcels). Extremely widespread on the Tonto National Forest, and occurs in the vicinity of all Tonto National Forest parcels (SEINet 2018; Tonto National Forest 2018).
Witchweed	*Striga spp.*	Federal ADA	Parasitic plant that attacks agricultural crops (Natural Resources Conservation Service 2018a).	No occurrence records in Arizona (Natural Resources Conservation Service 2018a).	Unlikely to occur (all). This species is not known to occur in Arizona.
Yellow starthistle	*Centaurea solstitialis*	TNF ADA	Prefers full sunlight and deep, well-drained soils where rainfall is 10–60 inches per year; most commonly occurs in disturbed areas (U.S. Forest Service 2018d). Generally occurs below 8,200 feet amsl elevation (White 2013).	Although the USDA PLANTS database only shows occurrence records in Yuma County (Natural Resources Conservation Service 2018a), other sources indicate that this species has become established in central Arizona, within the communities of Flagstaff, Camp Verde, Payson, Star Valley, and Young; on Tonto National Forest, this species occurs mainly on the higher-elevation districts (Payson and Pleasant Valley) but has been documented in the Tonto Basin below 3,000 feet amsl elevation (Tonto National Forest 2018).	May occur • Clear Creek • Turkey Creek • Cave Creek • Tangle Creek Occurrences in the vicinity (SEINet 2018; Tonto National Forest 2018), disturbance from dirt roads on-site. Unlikely to occur • Apache Leap South • Dripping Springs Distant from nearest known occurrence (SEINet 2018; Tonto National Forest 2018), minimal disturbance on site. Unlikely to occur • Appleton Ranch parcels • San Pedro River Distant from nearest known occurrence (SEINet 2018; Tonto National Forest 2018).
Yellow sweetclover	*Melilotus officinalis*	TNF	Occurs in cultivated, disturbed, or degraded areas along roadsides and within meadows, grassland, woodland, and forest communities at elevations typically ranging from 5,000 to 10,500 feet amsl (White 2013).	Has occurrence records in all Arizona counties except Greenlee, La Paz, Mohave, and Yuma (Natural Resources Conservation Service 2018a). This species is widespread in Arizona, and very common in riparian zones of the Tonto National Forest along the Verde River and on the Cave Creek Ranger District (Tonto National Forest 2018).	Unlikely to occur (all Tonto National Forest parcels). Apache Leap South, Cave Creek, and Tangle Creek are below the typical elevational range of this species, and Turkey Creek contains minimal disturbance and is 7 miles northwest of the nearest occurrence record (SEINet 2018).
Yellow toadflax	*Linaria vulgaris*	TNF	Occurs in cultivated, disturbed, or degraded areas along roadsides and within meadows, grassland, woodland, and riparian communities at elevations typically ranging from 6,400 to 9,200 feet amsl; germination highest on open sites with compacted soils and little vegetation (White 2013).	Has occurrence records in Coconino County (Natural Resources Conservation Service 2018a).	Unlikely to occur (all Tonto National Forest parcels). Known records are distant from all Tonto National Forest parcels (SEINet 2018) and all of the sites are below the typical elevational range of this species.

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APPENDIX C. PRACTICABILITY ANALYSIS IN SUPPORT OF CLEAN WATER ACT 404(B)(I) ALTERNATIVES ANALYSIS

DRAFT

PRACTICABILITY ANALYSIS IN SUPPORT OF CLEAN WATER ACT 404(B)(1) ALTERNATIVES ANALYSIS

Resolution Copper

Prepared for:

United States Army Corps of Engineers

On Behalf of:

RESOLUTION COPPER

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June 21, 2019

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APPENDICES

1. INTRODUCTION

Resolution Copper Mining, LLC (Resolution, or the Applicant) proposes to develop and operate an underground copper and molybdenum mine near Superior, Arizona. As proposed, the tailings storage facility (TSF), associated pipelines, and appurtenant infrastructure require the discharge of fill to surface water features that the U.S. Army Corps of Engineers (Corps) is anticipated to determine to be potentially jurisdictional waters of the United States (waters of the U.S.) pursuant to a preliminary jurisdictional determination (PJD). Based on the presumption that potentially jurisdictional waters of the U.S. will be impacted by discharges of dredged or fill material resulting from portions of Resolution's planned mine development, Resolution will need to make an application for a Clean Water Act (CWA) Section 404 permit for these discharges.

Because portions of Resolution's planned mine development occur on lands managed by the U.S. Forest Service (USFS) Tonto National Forest (TNF), Resolution submitted a General Plan of Operations (GPO) to the TNF in 2013 and subsequently amended it (Resolution 2016) to account for the USFS plan completeness review and the Southeast Arizona Land Exchange (land exchange) authorized in the National Defense Authorization Act (NDAA) for Fiscal Year 2015. The TNF deemed the GPO to be complete for the purpose of initiating review under the National Environmental Policy Act (NEPA) and has developed a draft of an Environmental Impact Statement (EIS) for the planned mine development and land exchange. Section 3003 of the NDAA authorized the exchange of lands between the federal government and Resolution and directed the USFS to prepare a single EIS as the basis for all decisions under federal law related to Resolution's proposed mine development. The NEPA analysis will ultimately lead to the issuance of a Record of Decision (ROD) by the USFS for Resolution's planned mining-related activities on National Forest System lands. The Corps is acting as a cooperating agency in the EIS process to meet its NEPA obligation triggered by Resolution's presumed need for a Section 404 permit authorizing the discharge of dredged or fill material to potential waters of the U.S.

Independent of the requirement to develop the EIS pursuant to NEPA and Section 3003 of the NDAA, an analysis of alternatives is required as part of Section 404 permitting in order to demonstrate compliance with guidelines established under CWA Section 404(b)(1) (40 CFR § Part 230; the Guidelines) for avoidance, minimization, and mitigation of impacts to waters of the U.S. A demonstration of compliance with the Guidelines is required before a Section 404 permit may be issued. The 404(b)(1) alternatives analysis is intended to ensure that no discharge be permitted "if there is a practicable alternative to the proposed discharge which would have less adverse impact on the aquatic ecosystem, so long as the alternative does not have other significant adverse environmental consequences" (40 CFR § 230.10(a)).

As discussed above, the Draft EIS (DEIS) analyzes the entirety of Resolution's planned mine development activities, as well as the congressionally authorized land exchange. Because only certain elements of Resolution's overall mine development activities involve a discharge of dredged or fill

material into potential waters of the U.S. (i.e., the development of the TSF, associated pipelines, and auxiliary infrastructure), only those activities are required to be analyzed by the Corps under the Guidelines. This practicability analysis has been developed to support compliance with the Guidelines, identifies the basic and overall project purpose, describes the alternatives selected for detailed analysis, evaluates the practicability of each selected alternative, and discusses the environmental effects of each practicable alternative. Once finalized, the Corps will use this practicability analysis to complete its 404(b)(1) alternatives analysis, which will be used in the Corps permitting decision-making process.

2. PROJECT DESCRIPTION AND PURPOSE

2.1. PROJECT DESCRIPTION

Resolution's planned mine development is located near Superior in Pinal County, Arizona (**Figure 1**) in an area called the Copper Triangle and specifically within the Pioneer Mining District. Mine exploration and operations have been conducted in the area since the early 1860's, when the discovery of silver led to the development of the Silver King Mine. Magma Copper Company (Magma) took over the Silver King Mine and operated it as the Magma Mine from 1912 until the concentrator was finally shut down in 1996. After Magma's shutdown, the Resolution ore deposit was discovered 1.2 miles south of the existing Magma Mine and 7,000 feet below the ground surface.

Resolution was formed as a limited liability company in 2004 by Rio Tinto and BHP Billiton. Rio Tinto is the managing entity and possesses a 55-percent ownership stake in Resolution, while BHP Billiton maintains 45-percent ownership. Since 2004, Resolution has steadily worked to investigate and delineate the Resolution ore body, develop a mine design, prepare environmental and engineering studies to support the mine permitting and approvals effort, and conduct multiple community outreach efforts and public meetings to inform and involve the public as plans were developed. These efforts led to the submittal of the GPO to the USFS in November 2013.

Resolution proposes the development of the Resolution ore body using panel caving, a type of cave mining. The copper and molybdenum ore will be mined, undergo primary crushing underground, and then be sent to a concentrator facility to be constructed at the existing West Plant Site north of Superior. Concentrate produced here will be transported offsite for additional processing, while the resulting tailings will be transported via a pipeline to the proposed TSF location. Under the current proposed operating conditions and Life of Mine (LOM) planning parameters, the Resolution ore body is sufficient to support the concentrator operations for approximately 41 years. As currently configured, operations are anticipated to result in the mining of approximately 1.4 billion tons of copper and molybdenum ore and the production of approximately 1.37 billion tons of tailings. While the mining process in general, and the planned locations of the ore and processing facilities in particular, are described in the GPO, locations for the TSF, pipelines, and auxiliary infrastructure are the primary subject of the alternatives analysis in the NEPA DEIS and the sole focus of this practicability analysis document. As configured, only the development of the TSF, pipelines, and auxiliary infrastructure require a discharge of dredged

or fill material into potential waters of the U.S. Discharge of fill for the development of these features, particularly the TSF, consists mostly of the levelling of existing topography through cut and fill of the natural ground surface. Materials to be discharged to potential waters of the U.S. during this process would consist primarily of native soil and rock taken from the footprint of the constructed features during the grading process.

Processing of the copper and molybdenum ore from the Resolution ore body will result in the production of two physically, mineralogically and geochemically distinct types of tailings: 1) the scavenger or non-potentially acid generating (NPAG) tailings, and 2) the pyrite or potentially acid generating (PAG) tailings. NPAG tailings contain less than 0.1 percent of pyrite by weight (Duke HydroChem 2016). NPAG tailings will account for approximately 84 percent, or approximately 1.15 billion tons, of the tailings produced during the LOM. In contrast, PAG tailings contain a much higher amount of pyrite (>20% by weight) and will account for 16 percent, or approximately 0.22 billion tons, of the tailings produced during the LOM (KCB 2018a). These two very distinct types of tailings, and the management requirements for each (especially the PAG tailings) informed the design and operation of the proposed TSF alternatives evaluated in both the DEIS and this document.

2.2. PURPOSE AND NEED FOR THE PROJECT

The Applicant's overall project purpose and need is to construct and operate a TSF and associated infrastructure capable of storing approximately 1.37 billion tons of tailings produced through milling copper and molybdenum ore from the Resolution ore body (plus approximately 12 million cubic yards of on-site borrow material used to construct the starter embankments), along with the pipelines and associated infrastructure needed to transport tailings to the TSF and recycled water from the TSF back to the concentrator facility. Capacity to deposit approximately 1.37 billion tons of tailings is required to allow for utilization of the Resolution ore body to the extent described in the GPO (mining of approximately 1.4 billion tons of ore). The Applicant's basic project purpose is mine tailings storage, which is not water-dependent. However, the proposed discharge will not affect a special aquatic site, so the rebuttable presumption in 40 C.F.R. § 230.10(a)(3) is not triggered.

3. FORMULATION OF PROJECT ALTERNATIVES

The USFS and cooperating agencies (including the Corps)[1] have evaluated a number of alternative TSF designs and locations for detailed analysis in the DEIS. This evaluation is contained in the DEIS and other documents cited herein but will be summarized in the balance of this **Section 3** to explain the selection of the alternatives analyzed in detail for compliance with the Guidelines. This practicability analysis document has been designed to be consistent with, and relies on, the detailed analysis of TSF alternatives contained in the DEIS and supporting documents. Most of these

[1] Henceforth in this document, references to the USFS in the context of development of the DEIS should be understood to include the agencies cooperating in the development of that document, including (but not limited to) the Corps.

alternatives, and the methodology for identifying them, are discussed in detail in the *Resolution Copper Project and Land Exchange Environmental Impact Statement DRAFT Alternatives Evaluation Report, November 2017* (SWCA 2017). Subsequently, another alternative (Skunk Camp) was identified for detailed analysis in the DEIS (USFS 2019).

The USFS utilized information gathered from public scoping, government-to-government consultation with Native American groups, and alternatives workshops to identify public values and develop screening criteria for reviewing alternative TSF development scenarios. Some of the key public issues raised during this scoping analysis were public health and safety, proximity to existing communities, and protection of aquatic and wildlife habitat (SWCA 2017). With these issues in mind, the USFS began evaluating the regional landscape to identify potential alternative TSF locations to that TSF location proposed in the GPO. The USFS systematically evaluated dozens of potential tailings locations and technologies for both the full volume and partial volumes (split volume storage) of tailings.

3.1. Geographic Scope for TSF Alternatives

In practice, transport distance for tailings is a significant factor in the economic recovery of the copper and molybdenum ore from the Resolution ore body, and the placement of tailings is not functionally independent of the fixed locus of that ore body. The USFS evaluated the landscape surrounding the Resolution mine to identify initial potential alternative locations for the TSF. Factors considered in this evaluation included locations within a reasonable proximity to the Resolution mine site, favorable topography, sufficient storage capacity, and a configuration suitable for conventional tailings impoundment construction as described in the GPO. As a part of this evaluation, the potential for use of previously disturbed, or 'brownfield', sites for TSF development was also included.

3.1.1. Brownfield Sites

The USFS evaluated brownfield sites associated with other current and previous mining operations not under the ownership of Resolution in locations up to 200 miles from the Resolution ore deposit. This evaluation included 15 brownfield sites not under Rio Tinto or Resolution Copper ownership, as well as the future subsidence zone anticipated from mining the Resolution ore deposit itself, as potential areas for the storage of tailings that might be available and practicable as alternatives to the development of a new TSF in a previously undisturbed location (SWCA 2017). These sites are shown in **Figure 2.** The evaluation considered whether the brownfield site had ongoing or publicly stated planned future mining operations, had other ongoing site activities, and had the capacity to contain a necessary volume of tailings (factors relating to the availability of the site under the Guidelines). Included in the evaluation of capacity for tailings storage was an investigation of the use of multiple brownfield sites so site capacity was evaluated for both storage of the total volume of tailings and storage of only the total volume of PAG tailings. If sites were available and practicable under these initial screening factors, they were further evaluated to determine if they were within a reasonable distance for the pumping of tailings. The evaluated sites are listed in **Table 1**.

Table 1. Brownfields Sites Investigated for Potential Tailings Storage (adapted from SWCA 2017)

Site Name	Ownership	Mining Activity Status	Approximate Distance (miles)[1]
Ajo	Freeport-McMoRan	Copper mine, potential for future operation	120
Carlota	KGHM International Ltd.	Copper mine, current operation	10
Casa Grande	ASARCO LLC	Copper mine, closed operation	49
Copper Queen	Freeport-McMoRan	Copper mine, closed operation, tourism	145
Copperstone	Kerr Mines Incorporated	Gold mine, closed operation	190
Sierrita	Freeport-McMoRan	Copper mine, current operation	100
Johnson Camp	Excelsior Mining Corp.	Copper mine, potential for future operation	100
Miami and Inspiration	Freeport-McMoRan	Copper mine, closing	15
Miami Unit and Copper Cities	BHP Copper Inc.	Copper mine, closing	15
Pinto Valley Mine	Pinto Valley Mining Corp.	Copper mine, current operation	11
Ray Mine	ASARCO	Copper mine, current operation	11
Resolution Copper Subsidence Zone (potential future brownfield site)	Resolution Copper	Copper mine, potential for future operation	3
San Manuel	BHP Copper Inc.	Copper mine, closed operation	45
Tohono Cyprus	Freeport-McMoRan	Copper mine, potential for future operation	70
Twin Buttes	Freeport-McMoRan	Copper mine, potential for future operation	95
United Verde	Phelps Dodge Corporation	Copper mine, closed operation	115

1 Distances measured in aerial miles between Resolution ore body and brownfields facility. The total length to construct appropriate infrastructure (pipelines, etc.) would be considerably longer.

The initial evaluation of the brownfield sites indicated that almost none of the sites had the capacity to accommodate the total volume of tailings from the Resolution ore body and were, therefore, not practicable alternatives to the operation of a single TSF as described in the GPO. Nine of the alternatives either have current operations or proposed future operations that would make them unavailable for the storage of tailings from the Resolution ore body. The closed operations at Casa Grande, Copperstone, and United Verde lacked the capacity to completely contain even the PAG portion of the anticipated tailings and would require the operation of multiple TSFs solely for the PAG tailings (SWCA 2017). These operations were not practicable alternatives for the TSF and were dropped from further consideration. Copper Queen in Bisbee, Arizona is currently used for tourism and was considered unavailable as a potential tailings storage site. Additionally, this site would require an extensive pipeline traversing more than 145 straight-line miles and crossing multiple divisions of federal, state, tribal, and private lands such as to be technologically impracticable.

The Miami and Inspiration site, the Miami Unit and Copper Cities sites, and the San Manuel site were dismissed from consideration because of environmental considerations related to potential ground and surface water quality impacts associated with the storage of the PAG tailings (SWCA 2017). The Miami and Inspiration site and the Miami Unit and Copper Cities sites are located within the Pinal Creek Water Quality Assurance Revolving Fund (WQARF) site and are currently undergoing closure and remediation activities for impacts to groundwater. Similarly, storage of the PAG tailings in the San Manuel pit was determined to have the potential to deliver poor quality groundwater to the San Pedro River, given the characteristics of the PAG material and the pit's proximity to the river (SWCA 2017). As such, none of these three alternatives could be considered practicable alternatives for a TSF.

Use of the final brownfield site, the future subsidence zone anticipated from mining the Resolution ore deposit itself, was reviewed as a potential TSF location. The scenario included the placement of either conventional or dry stack tailings on the land above the mining panels, which would gradually become the subsidence pit. The subsidence pit would continue to be filled with tailings as mining continued and the subsidence expanded over time. Safety concerns to operations and personnel both aboveground and belowground from the deposition of tailings above the active panel caving operations (SWCA 2017) make this alternative impracticable and it was removed from further consideration.

It was ultimately determined that none of the brownfield sites were available, feasible, or reasonable alternatives for TSF locations and those sites were therefore dismissed from detailed analysis (SWCA 2017). As none of these sites meets the criteria for availability and/or practicability under the Guidelines, even using these limited screening criteria, they were also dismissed form further consideration in this practicability analysis.

3.1.2. Multiple TSF Locations

Although the potential for use of multiple sites for the storage for tailings was investigated by the USFS as part of the evaluation of brownfield TSF locations, the use of multiple TSFs was also considered in the development of the alternatives evaluated in this practicability analysis. In general, the use of multiple smaller sites for the storage of tailings is problematic from an operations and maintenance (as well as environmental) perspective, when compared to a single TSF site. Splitting the footprint of a TSF designed for a given capacity into multiple smaller TSFs designed to store that same capacity often results in a greater overall footprint, given the need to duplicate infrastructure.

Impoundment embankments, pipelines, seepage controls, and other auxiliary infrastructure (e.g., roads, power, pumping stations, buildings, vehicle storage/maintenance, and various environmental-management measures such as stormwater ponds, run-off collection, and run-on diversion structures) are required for the operation of a TSF of any size. All these structural components and appurtenant features would need to be constructed and operated at each of the smaller TSFs in a multiple TSF scenario. Starter dam, embankment, and capping materials would be required for each of the multiple

TSF locations. Separate tailings delivery and recycle water return pipelines would also be necessary for each TSF, further increasing the disturbance footprint. As described in **Section 3.2.2**, the transport of the two types of tailings, NPAG and PAG, will be through separate pipelines, further increasing the infrastructure needs associated with multiple TSFs. The duplicative infrastructure required for multiple TSF sites as compared to use of a single site would be expected to result in a larger combined footprint of impact for the multiple TSF over a single TSF of the same storage capacity.

In addition to the consideration of the physical footprint of a single TSF facility in one location versus multiple TSF footprints dispersed over a larger area, the use of multiple TSFs also spreads the potential for environmental effects to additional locations. Effects such as impacts to the aquatic ecosystem, visual impacts, land use compatibility, ground and surface water quality, and air quality would occur at multiple locations, rather than a single location. These effects would be spread over a much larger area when considering the separate facilities, as would the potential for impacts from process upsets, pipeline failures, or seepage. Operating multiple TSF sites when a single site with the necessary capacity exists increases both the operations and maintenance requirements and potential environmental impacts from process upsets.

Given the extensive infrastructure requirements for multiple TSFs and the potential spread of environmental effects to multiple locations, the use of multiple TSFs compared to a single TSF was not carried forward in this analysis.

3.1.3. Initial TSF Alternative Screening

After dismissal of the brownfield alternatives, 15 initial alternative TSF locations to that location proposed in the GPO were further evaluated (SWCA 2017, USFS 2019). The 15 initial locations (**Figure 3**) were screened and assessed using criteria developed from the public and agency scoping processes conducted by the USFS (SWCA 2017) as well as input from cooperating agencies and Resolution Copper. These general screening criteria included locations that were within approximately 20 miles of the West Plant Site, sites that avoided landscape barriers such as mountains or rivers, sites outside rugged terrain to steep for TSF development, and sites potentially near existing or historic mining operations. Resolution Copper's feedback was informed by input from the Resolution Copper Independent Tailings Review Board (ITRB), comprised of internationally recognized industry experts in the field of tailings, with involvement in post tailings failure reviews. Numerous aspects of TSF design and construction such as embankment type (e.g., upstream, centerline, modified centerline, and downstream embankments), foundation treatment and lining options, management of PAG tailings, and deposition methods (e.g., conventional thickened, high-density thickened, and filtered, or 'dry-stack') were assessed for use at these locations as described in the DEIS (USFS 2019). Pertinent portions of this analysis are discussed below in the context of the Guidelines.

3.2. Tailings Impoundment Design and Operations

Brief descriptions of the types of TSF embankment design and tailings placement technologies are provided as follows. Additional detail is available in the DEIS (USFS 2019).

3.2.1. Tailings Embankment

There are four main embankment types for constructing a raised TSF, which are known as upstream, centerline, modified centerline, and downstream. The names of the types refer to the direction of movement of the TSF embankment's centerline in relation to the starter dam initially constructed at the toe of the TSF impoundment. Filtered tailings stacks also require an outer structural zone to meet stability requirements, as discussed in **Section 3.2.1**. The differences in embankment design for each of the TSF alternatives are included in the TSF descriptions in **Section 4**.

Upstream Raised Embankment

For a TSF using an upstream raised embankment, the starter dam is constructed at the ultimate TSF toe and successive, or 'lifts,' are constructed with the crest of each berm offset towards the interior of the TSF or 'upstream' of the starter dam. This form of embankment is constructed of the tailings themselves and is generally considered the least robust and resilient embankment type as it relies on a well-drained shell and the strength of the tailings themselves for stability. The upstream method of embankment construction, which had been proposed in the GPO, was formally dismissed as part of the USFS alternatives analysis for the DEIS.

Downstream Raised Embankment

For a TSF using a downstream raised embankment, the starter dam is constructed within the ultimate impoundment and successive berms, or 'lifts,' are constructed with the crest of each berm offset towards the exterior of the TSF or 'downstream' of the starter dam. This form of embankment is typically constructed for containment of water for reservoirs or flood control. This can be a very robust and resilient embankment type because the embankment stability is not reliant on the strength of the tailings but generally requires the largest volume of material to construct. Due to the large volume required for this embankment type, it can present a challenge for three-sided embankments and areas where topography and land ownership constrains the TSF footprint. This embankment type is proposed for the secondary PAG tailings storage embankment within the larger Skunk Camp and Peg Leg TSFs.

Centerline Raised Embankment

For a TSF with a centerline raised embankment, the starter dam is constructed within the ultimate impoundment and successive berms, or 'lifts', are constructed with the crest of each berm directly above the starter dam and previous lift, the embankment crest not moving either towards or away from the TSF interior. As with the downstream embankment, this embankment type requires a

relatively large volume of materials for construction and is a very robust and resilient embankment type. This embankment type is proposed for storage of the NPAG tailings embankments for the Peg Leg and Skunk Camp TSF alternatives.

Modified Centerline Embankment

Some of the TSF alternatives considered in detail in the DEIS and, therefore, in this practicability analysis document, utilize what are known as 'modified centerline' embankments. As described in Chapter 2 of the DEIS (USFS 2019), modified centerline embankments do move 'upstream' of the starter dam over time and involve some construction of embankments over tailings, but contain a more substantial structural zone as compared to an 'upstream' embankment design. The Near West 'Wet' and Near West 'Dry' TSF alternatives propose use of this embankment method.

3.2.2. Tailings Processing and Placement Technologies

The processing and placement method used for the deposition of tailings can be a determining factor in the design of the TSF and generally has a great effect on the delivery of tailings from the concentrator facility to the TSF for storage. Where differences in tailings placement methods are pertinent to the analysis of alternatives, this information is included in the TSF descriptions in **Section 4**. All TSF alternatives, included in Chapter 2 of the DEIS (USFS 2019), consist of separation and thickening of the NPAG and PAG tailings at the concentrator facility. Thickening tailings involves the mechanical process of removing some water from the tailings while still maintaining a concentration of water that allows the tailings to be transported via pipeline. The two types of tailings, NPAG and PAG, are transported to the TSF facility though separate pipelines within the same corridor. Brief descriptions of tailings placement technologies evaluated are provided as follows.

Sub-aqueous Deposition of PAG Tailings

In this method of tailings placement, PAG tailings are thickened at the concentrator to 50 to 55 percent solids and then transported to the TSF via pipeline. Sub-aqueous deposition of PAG tailings is a Best Management Practice (BMP) method used to prevent and minimize acid rock drainage (ARD). For all alternatives except Silver King (Filtered), the PAG tailings are discharged sub-aqueously into the reclaim pond from a barge in a separate area to the NPAG tailings deposition area. Near West 'Wet' includes the reclaim pond and PAG tailings area within the NPAG beach (not in a separate cell).

Near West 'Dry', Peg Leg and Skunk Camp alternatives all store PAG tailings in physically separate cells. However, Peg Leg PAG cells are separate from the NPAG impoundment, whereas, the Near West 'Dry' and Skunk Camp PAG cells would ultimately be encapsulated by the NPAG impoundment. As a result, the reclaim water pond would only overlie the PAG tailings, reduced in size from that typically needed for Near West 'Wet'. Limited and small low spots that accumulate

water either released from the tailings or stormwater on the NPAG surface would also be directed to the PAG tailings cell.

Tailings Placement via Conventional Thickened Deposition

In this method of tailings placement, NPAG tailings are thickened at the concentrator facility to 60 to 65 percent solids and transported to the TSF via pipeline. At the TSF, the NPAG tailings are processed through hydrocyclones to produce a coarse particle tailings stream used to construct the embankment, and the finer particle tailings stream is deposited into the interior of the impoundment. Hydrocyclones require the input tailings stream to be between 30 to 40 percent solids, resulting in the finer particle tailings stream to have a high water content. Typically, the finer particle tailings stream is directly discharged into the facility with the high water content. Alternatively, the finer particle tailings stream can be thickened at the TSF site prior to discharge. This tailings placement technology is evaluated in the Near West 'Wet' TSF alternative with the finer particle tailings stream thickened to 50-percent solids.

Tailings Placement via High-density Thickened Deposition

Similar to conventional thickened deposition, tailings are transported to the TSF via pipeline after thickening at the concentrator facility. Additional thickeners located at the TSF facility remove and recycle water to further thicken the tailings prior to deposition. These tailings are deposited at between 60- to 70-percent solids. Like conventional thickened tailings, the NPAG tailings are processed through hydrocyclones to produce a coarse particle tailings stream used to construct the embankment, and a finer particle tailings stream that is placed into the interior of the impoundment. The high-density thickened deposition also involves, to the extent practicable, placement of tailings in thin layers, called "thin-lift," to further reduce entrained water through evaporation and thus reduce seepage. Alternatives that incorporate this type of tailings placement technology include the Near West 'Dry', Peg Leg, and Skunk Camp TSF alternatives.

Filtered Tailings ('Dry-Stack')

In this method of tailings placement, tailings are transported to the TSF via pipeline where they are filtered to reduce the moisture content to approximately 85-percent solids. This process reduces the moisture content to the point where transportation and placement via pipeline is no longer possible and placement of the dewatered tailings in the TSF must be accomplished via mechanical means, such as by truck or conveyor. Dry-stack impoundments can be constructed in horizontal lifts using of a structural outer shell that supports the non-structural zone upstream.

Key considerations when assessing the reasonableness, practicality, and benefits of a tailings management strategy are the precedents and lessons learned from case histories. Most dry-stack tailings facilities operate with throughput capacity between 2,000 and 10,000 tons per day (tpd) with dam heights of less than 200 feet. The current demonstrated industry maximum throughput capacity for operating dry-stack facilities at other mines is approximately 20,000 tpd to more recently

approximately 40,000 tpd. The proposed concentrator facility for the Resolution Copper Project will have a throughput of approximately 132,000 tpd and a dam height of approximately 1000 feet for the Dry Stack alternative. To date, the maximum slope height of filtered tailings embankments achieved is approximately 200 feet (further detail can be found in **Appendix A**: *Resolution Copper Mining, LLC – Mine Plan of Operations and Land Exchange – USFS Alternatives Data Request #3-F, Information on Potential Tailings Alternatives*). While the dry-stack technology needed to meet the overall project purpose is unproven, this method was carried forward for further analysis in one TSF alternative to remain consistent with the analysis provided in the DEIS. This tailings placement technology is evaluated in the Silver King TSF alternative.

3.3. Initial Alternatives Dismissed from Further Consideration

The 15 initial alternative TSF locations to that location proposed in the GPO were analyzed for improvements upon key issues of concern identified in scoping by the public and agencies, and screened to identify potential environmental impacts that could result from the development of a TSF under that alternative. The 15 alternative locations, as well as the construction of a dry-stack impoundment at the proposed GPO TSF location, were included in this screening (**Figure 3**) using the screening criteria described in **Section 3.1**. These sites and their disposition are listed in **Table 2**.

Table 2. Initial Alternative TSF Locations Dismissed from Consideration (adapted from USFS 2019, Appendix B)

Alternative Location	Dismissed?	Rationale
BCG A	Yes	Closer to potential receptors and includes lands not available as described in the Far West alternative below. Dismissed from further consideration.
BCG B	Yes	Partially located on Bureau of Land Management (BLM) lands that are withdrawn from mineral entry by the Bureau of Reclamation (BOR) and therefore not available. Dismissed from further consideration.
BCG C	Yes; but became Peg Leg alternative	Partially located on BLM lands that are withdrawn from mineral entry by the BOR and therefore not available. Although dismissed from consideration another configuration of BCG C became the Peg Leg alternative.
BCG D	Yes	Partially located on BLM lands that are withdrawn from mineral entry by the BOR and therefore not available. Proximity to the Gila River presents challenges for seepage and therefore not technologically practicable. Dismissed from further consideration.
Dry-Stack at GPO	Yes; but became Near West alternatives	Water management issues and pipeline corridor are logistically impracticable. Although dismissed from consideration, configurations of conventional tailings and high-density thickened tailings at this location became the Near West 'Wet' and 'Dry' alternatives.
Far West	Yes	The USFS approached the Arizona State Land Department (ASLD) about the potential availability of these State Trust lands for a TSF. The ASLD plans to use these lands for residential development and expressed an unwillingness to sell them. They are therefore not available as an alternative. Dismissed from further consideration.

Table 2. Initial Alternative TSF Locations Dismissed from Consideration (adapted from USFS 2019, Appendix B)

Alternative Location	Dismissed?	Rationale
Hewitt Canyon	Yes	Location in proximity to Superstition Wilderness Class I airshed would prevent air permit compliance. Substantial watershed without a means to divert upper catchment around tailings and all runoff would have to be captured and contained within the TSF. Embankment would be approximately 1,000 feet in height, an unprecedented height for TSF embankments in North America, with a likely determination of extreme consequence based on dam classification. Considered not technologically or logistically practicable. Dismissed from further consideration.
Lower East	Yes	Location and configuration similar to impacts and challenges of Near West alternatives, but closer to sensitive receptors of Boyce Thompson Arboretum, residents, and U.S. 60. Extreme consequence of failure due to proximity to sensitive receptors and critical infrastructure. Dismissed from further consideration.
Silver King	Yes; but became Silver King Dry-Stack alternative	Conventional tailings deposition design at this location was not available because of historic cemetery and adverse mineral estate, and technologically impracticable because of historic mine workings. Although dismissed from consideration another configuration using dry-stack tailings is carried forward for analysis.
SWCA 1	Yes	Located adjacent to BLM lands withdrawn from mineral entry by the BOR. Seepage collection and other appurtenant infrastructure would need to be located on these withdrawn lands and therefore the alternative is not available. Proximity to the Gila River and terrain also present challenges for seepage and stormwater management. Dismissed from further consideration.
SWCA 2	Yes	Partially located on BLM lands that are withdrawn from mineral entry by the BOR; therefore, the alternative is not available. Proximity to the Gila River and terrain present challenges for seepage and stormwater management. Dismissed from further consideration.
SWCA 3	Yes	Location is on steep ridge crest and occupies portions of both the Queen Creek and Gila River watersheds. As such, it would require substantial engineering controls to minimize seepage from multiple locations that would be impracticable to implement. Rugged topography makes it unlikely to have available capacity for all tailings volume and presents substantial difficulties for infrastructure, structures, and equipment. Not in keeping with good engineering practices and technologically impracticable. Dismissed from further consideration.
SWCA 4	Yes	Partially located in Superstition Wilderness and therefore not available. Dismissed from further consideration.
Telegraph Canyon	Yes	Telegraph Canyon contains a perennial stream segment along with valuable riparian habitat identified as Important Bird Areas, as well as several springs, and may contain wetlands associated with the perennial flow. Dismissed from further consideration.

Table 2. Initial Alternative TSF Locations Dismissed from Consideration (adapted from USFS 2019, Appendix B)

Alternative Location	Dismissed?	Rationale
Upper Arnett	Yes	Alternative contains a perennial segment of Arnett Creek. This creek may support wetlands associated with the perennial flow. The location is also proximate to State Route 177 that constrains TSF design and the steep canyon sidewalls do not provide sufficient capacity for all the tailings volume. Dismissed from further consideration.
Whitford Canyon	Yes	Location in proximity to Superstition Wilderness Class II airshed would prevent air permit compliance. Substantial watershed without a means to divert upper catchment around tailings and all runoff would have to be captured and contained within the TSF. Embankment would be approximately 1,000 feet in height, an unprecedented height for TSF embankments in North America. Considered not technologically or logistically practicable. Dismissed from further consideration.

As none of the initial alternatives met the general screening criteria defined herein and the criteria for practicability under the Guidelines, they were dismissed from further consideration in the DEIS (SWCA 2017, USFS 2019) and this practicability analysis. The upstream method of tailings embankment construction was dismissed from further analysis, as well. This screening analysis did, however, identify four new TSF alternatives at three of the previously investigated locations. The Peg Leg Alternative resulted from a reconfiguration of the TSF proposed at BCG C, and the Near West 'Wet' and 'Dry' Alternatives resulted from the screening and analysis performed for the Dry-Stack at GPO Alternative. The Silver King location was identified for analysis as a potential dry-stack TSF. These four alternatives are described in **Section 3.4** and are considered in detail in both the DEIS and this practicability analysis document.

Two additional alternatives at locations not previously considered were brought forward for screening at this time. These alternatives, the Mineral Creek Headwaters Alternative and the Upper Dripping Springs Wash Alternative, are shown in **Figure 4**. Although the Mineral Creek Headwaters Alternative site may have sufficient capacity to store the total anticipated volume of tailings, it is located within a perennial segment of Mineral Creek (SWCA 2017) that is designated as critical habitat for the endangered Gila Chub (*Gila intermedia*) and may also support wetlands associated with the perennial flow. The Mineral Creek Headwaters Alternative was considered unavailable and dismissed from further review in both the DEIS and this practicability analysis document.

The initial screening of the Upper Dripping Springs Wash Alternative did not identify any high-level availability or practicability issues with this alternative location. The alternative footprint includes only ephemeral drainages, does not contain any potential wetlands, and avoids seeps and springs in the area. The alternative was renamed the Skunk Camp Alternative and carried forward for detailed review in both the DEIS and this practicability analysis document.

3.4. Alternatives Considered in Detail

Five TSF alternatives were considered for detailed analysis in the DEIS (USFS 2019), which included a mix of locations, embankment types, and tailings deposition and placement technologies. These same alternatives passed the general screening criteria described above and are carried forward for more detailed consideration in this practicability analysis. The alternatives for detailed analysis are as follows:

- Near West 'Wet' TSF (conventional thickened tailings)
- Near West 'Dry' TSF (ultra thickened tailings)
- Silver King TSF (dry-stack tailings)
- Peg Leg TSF (ultra thickened tailings)
- Skunk Camp TSF (ultra thickened tailings)

These final TSF alternatives are fully analyzed in the DEIS to disclose impacts to the natural and social environment. Per the Guidelines, the evaluation of these alternatives provided herein will focus on alternative practicability, impacts to the aquatic ecosystem, and other significant adverse environmental consequences.

4. TSF ALTERNATIVES DESCRIPTION AND PRACTICABILITY DETERMINATION

This section describes the five TSF alternatives (**Figure 5**) identified for detailed analysis by the USFS in the DEIS (USFS 2019) and provides description for each , including the acreages of impacted undisturbed land reported to the nearest whole acre. An alternative is to be deemed practicable, "if it is available and capable of being done after taking into consideration cost, existing technology, and logistics in light of overall project purposes" (40 CFR § 230.10(a)). The alternatives considered in this analysis have been evaluated for these elements of practicability. Details of each alternative are followed by a determination of the alternative's practicability based on the criteria defined in the Guidelines at 40 CFR §230.10(a)). One of the key practicability criteria applied to this analysis of TSF alternatives is discussed in **Section 4.1**.

4.1. Project-Specific Practicability Criteria

A critical element in determining the logistical and technological practicability of a TSF alternative is the ability (or lack thereof) to capture and control seepage from the TSF in a manner that reliably allows the facility to meet all applicable standards and obtain and operate in compliance with required environmental permits. Numerical models were developed for each TSF to predict the amount of uncollected seepage for each TSF alternative. These seepage models were developed based on the hydrogeological setting of each TSF site and represent steady-state conditions assuming operational conditions at full TSF build-out. Levels of engineering seepage controls were also developed for implementation at each TSF site and are described in detail in Section 3.7 of the DEIS (USFS 2019).

The levels of engineering control and estimated efficiency are based on Best Available Demonstrated Control Technology (BADCT) for seepage controls, as well as other discharge control technologies, as defined by the Arizona Department of Environmental Quality (ADEQ). Engineering controls to reduce seepage are characterized in the models by level, or efficiency, of control. These levels are generally specific to each alternative and location. Descriptions of each TSF alternative's levels are described in **Section 4.2** and tables taken from the *Resolution Copper Project Summary of DEIS Tailings Alternatives Seepage Control Levels* (KCB 2019) are included as **Appendix B** of this document. It should be noted that the seepage engineering controls included within each defined level are slightly different for each TSF alternative due to site-specific conditions. However, the greater the number of controls required in each level, and the presence of higher level controls, denote an increased degree of complexity in terms of those engineered controls.

The numerical models, described above and explained in detail in the DEIS, were used to estimate the uncaptured seepage in acre-feet per year (AF/yr). GoldSim models taking into account these engineered controls were then used to predict potential transport of any uncollected seepage through the aquifer to surface water receptors. In order to operate a TSF, Resolution must obtain an Aquifer Protection Permit (APP) from ADEQ, which requires the mine facility to demonstrate that it will not cause or contribute to an exceedance of Aquifer Water Quality Standards (AWQS) at the point of compliance, or, if, AWQS for a pollutant has been exceeded in an aquifer, that no additional degradation will occur [A.R.S. § 49-243(B)(2)-(3); AAC R18-9-A202(A)(8)(a)]. Seepage must also not contribute to the exceedance of any ADEQ surface water quality standards where groundwater may emerge and contribute to surface flow [AAC R18-11-405(b)].

The concentrations of regulated constituents in the seepage were modeled both with and without the background water quality. An analysis of the total predicted concentrations (modeled plus background) of pollutants was used to calculate the preliminary allowable seepage rate in AF/yr that would allow each TSF to operate over the LOM and post-closure (245 years) periods without exceeding water quality standards. The total predicted concentrations are compared to the ADEQ groundwater and surface water quality standards at the Points of Compliance (POC) downgradient of each TSF footprint (750 ft downgradient for groundwater; site-specific locations for surface water). The POC for Near West 'Wet' and 'Dry', and Silver King alternatives, is in the last groundwater cell nearest to Whitlow Ranch Dam, which provides the majority of surface flow at the dam. The POC for Peg Leg and Skunk Camp alternatives is located at the confluence of Gila River at Donnelly Wash and Dripping Springs Wash, respectively. The background water quality, surface water flow rate, and distance to the POC are critical in determining the potential seepage impacts to downstream surface water quality.

For each alternative, a maximum uncollected seepage rate was modeled that would allow compliance with surface water quality standards at the POCs noted above, as is necessary in order to secure an APP. If exhaustive and multiple seepage controls are installed and the TSF cannot meet standards and

secure an APP, then it was determined that the TSF is technologically impracticable for the purposes of this assessment.

4.2. Detailed Evaluation of DEIS Alternatives

A description and discussion on the practicability of each TSF alternative is provided in the following sub-sections. The alternatives evaluated are as follows:

- Near West 'Wet' TSF
- Near West 'Dry' TSF
- Silver King TSF
- Peg Leg TSF
- Skunk Camp TSF

4.2.1. Near West 'Wet' TSF Alternative

4.2.1.1. Description

The Near West 'Wet' TSF Alternative (Alternative 2 in the DEIS) proposes the construction of a modified centerline embankment on USFS lands with approximately 1.37 billion tons of tailings storage capacity using conventional thickened tailings deposition as described in **Section 3.3**. The associated tailings transportation corridor would also be located on USFS and private lands owned by Resolution. This TSF alternative would be approximately 4,909 acres in size with an ultimate embankment crest reaching 520 feet in height.

The location of the Near West 'Wet' TSF is underlain by a mix of different age bedrock incised with narrow channels infilled with alluvial, colluvial and undifferentiated sediments (KCB 2018a). Gila Conglomerate makes up 55 percent of the Near West 'Wet' TSF overall foundation, while a mixture of limestones, sandstones and quartzites are located along the footprint of the NPAG's starter dam, the TSF embankment, and the northern portion of the TSF. The conglomerate, limestone, and sandstone sediments all possess a potential for reduced foundation strength, especially if exposed to long-term saturation and have potential to allow seepage into adjacent canyons (KCB 2018a).

The proposed Near West 'Wet' TSF is located near the center of Superior Basin, which drains ultimately into Queen Creek. Stormwater diversion channels would be required for this TSF alternative to redirect flow from the 4.91-square-mile upper watershed of Bear Tank Canyon to adjacent watershed of Roblas Canyon and Potts Canyon (SWCA 2018).

The Queen Creek aquifer in the vicinity of the Near West TSF location is relatively small with groundwater levels approximately 50 feet below ground surface and in relatively close proximity to the TSF footprint. As such, extensive seepage controls have been proposed for this alternative, including the following (KCB 2018a, 2019):

Level 0

- Underdrain system comprising a drainage blanket and finger drains beneath the entirety of the embankment to drain to seepage collection ponds

Level 0-1

- Extension of embankment underdrains beneath the entirety of the starter dam and into the impoundment under the entire NPAG tailings beach area
- In each drainage channel surrounding the TSF there will be a primary seepage collection system including lined seepage collection ponds, cutoff walls and pump back wells to return and recycle the collected seepage
  - A total of 12 cutoff walls will be excavated through alluvium, filled with compacted granular fill and grouted to competent bedrock

Level 1

- Further extension of the underdrain system an additional 200 feet into the impoundment beyond the beach area
- Lined channels downgradient of the embankment to direct captured seepage to the primary seepage collection system
- Foundation treatments and/or selective engineered low permeability layers in areas of the foundation where Gila Conglomerate not present
- Placement of an engineered low permeability layer for the PAG tailings starter facility
- Encapsulation of PAG into the low permeability NPAG tailings fines and sealing of the NPAG foundation with fines
- Addition of grout curtains extending to 100 feet below ground paired with each cutoff wall as part of the primary seepage collection system

Level 2

- Further extensions and deepening of the grout curtains described in Level 1 to target higher permeability zones and potential seepage pathways

Level 3

- Auxiliary seepage collection system downgradient of the primary seepage collection system in drainages surrounding the TSF facility comprising additional cutoff walls, seepage collection ponds, and wells to pump the collected and recycle water back to the TSF

Level 4

- Low permeability liners in areas of the foundation where Gila Conglomerate not present
- Engineered low permeability liner for the entire PAG cell
- Addition of an auxiliary grout curtain extending to 100 feet below ground paired with cutoff walls as part of the auxiliary seepage collection system; total of 7.5 miles in length
- Up to 21 pump back wells between the auxiliary seepage collection system and Queen Creek

Seepage modeling studies indicate that by using Levels 0 through 4 (KCB 2018a, 2019) of the engineered seepage controls detailed above, this facility would have uncollected seepage rates of 20.7 AF/yr and that the concentration of selenium will ultimately exceed state-established surface water quality standards. Montgomery (2019b) modeled a preliminary allowable maximum uncollected seepage rate of 3 AF/yr for compliance with surface water quality standards, well below the 20.7 AF/yr estimate. This allowable rate of uncollected seepage was based on the constituent that resulted in the lowest seepage flow rate prior to exceeding the regulatory threshold (selenium).

4.2.1.2. *Practicability of Alternative*

The Near West 'Wet' TSF Alternative is determined to be not practicable. While this alternative would meet the overall project purpose, the allowable seepage rate needed to avoid exceeding the aquatic and wildlife warm water quality standard for selenium is unachievable, even with extreme and extensive seepage controls. As such, it is unlikely that Resolution could secure the required APP from ADEQ. Therefore, this alternative is not technologically practicable and is not carried forward for further analysis.

As noted above, development of this alternative would result in concentrations of selenium above state-established surface water quality standards. In addition, seepage from this tailings facility would result in dissolved copper loading of Queen Creek, which has been determined to be impaired for copper by ADEQ. This alternative would increase the copper loading in Queen Creek by 7 to 22 percent, interfering with the state's efforts to reduce the loading in this impaired feature.

4.2.2. Near West 'Dry' TSF Alternative

4.2.2.1. *Description*

The Near West 'Dry' TSF Alternative also proposes the construction of a modified centerline embankment on USFS lands with approximately 1.37 billion tons of tailings storage capacity. The approximate TSF footprint is 4,909 acres in size with an ultimate embankment crest 510 feet in height. The tailings transportation corridor would also be located on USFS and private lands owned by Resolution (KCB 2018b). Compared to the 'Wet' Alternative, the Near West 'Dry' Alternative physically separates the PAG and NPAG tailings with a splitter berm and proposes ultra thickening of NPAG tailings. By isolating PAG tailings and ultra thickening the NPAG tailings, drier conditions are maintained, resulting in reduced seepage into the foundation.

The proposed Near West 'Dry' TSF Alternative is located within the same footprint as the Near West 'Wet' TSF Alternative and, therefore, possesses similar geologic and hydrologic conditions. This alternative would require upstream stormwater diversions and all the same Levels 0 through 4 of extensive engineered seepage controls as the Near West 'Wet' TSF Alternative described above. However, this configuration does allow the interior finger drain system to function more effectively for greater seepage capture. This more effective seepage capture, in combination with the Levels 0

through 4 seepage controls (KCB 2018a, 2019), the physical separation of PAG and NPAG tailings, and high-density thickening the NPAG tailings, is modeled to result in 2.7 AF/yr of uncollected seepage, which is slightly below the modeled allowable maximum seepage of 3 AF/yr (Montgomery 2019b) needed to meet surface water quality standards at the POC identified for this alternative. No chemical constituents are anticipated in concentrations above established surface and groundwater quality standards.

4.2.2.2. Practicability of Alternative

The Near West 'Dry' TSF Alternative is determined to be practicable, although it would require implementation of a degree of engineering control that is not typical of large-scale copper porphyry tailings facilities. Individually, the seepage control measures have been implemented at small, medium and large-scale projects, but the engineering controls described for this alternative combine a multitude of the available seepage controls and would be implemented on a larger scale than typical. The location of this alternative is currently available and has the capacity to meet the overall project purpose. Like the Near West 'Wet' TSF Alternative, this alternative would still require an extreme and extensive seepage control system, in comparison to the other TSF designs, in order to maintain ADEQ water quality standards. However, more extensive finger drains and thickening of tailings reduces overall seepage, allowing the engineered controls to capture enough seepage to meet water quality standards and potentially secure an APP from ADEQ. Based on the predicted uncollected seepage rates being so close to the allowable maximum rates to achieve compliance with water quality standards, this TSF alternative would need to consistently capture 99.5 percent of seepage. As noted in the DEIS (USFS 2019), "the high capture efficiency required of the engineered seepage controls could make meeting water quality standards under this alternative challenging. The number and types of engineered seepage controls represent significant economic and engineering challenges."

Seepage from this tailings facility would result in dissolved copper loading of Queen Creek, an impaired water. This alternative would increase the copper loading in Queen Creek by 1 to 2 percent, impeding the state's efforts to reduce the loading in this impaired feature.

Impacts to the aquatic ecosystem as well as other potential adverse environmental consequences of this alternative are described further in **Section 5**.

4.2.3. Silver King TSF Alternative

4.2.3.1. Description

The Silver King TSF Alternative proposes the construction of two separate impoundments using the dry-stack method, one with approximately 1.15 billion tons of NPAG tailing capacity and one with 0.22 billion tons of PAG tailing capacity. In contrast to the other TSF alternatives, the dry-stack TSF would not require an embankment, but rather the compacted zone of tailings around the perimeter of the dry-stack facility provides structural support (USFS 2019). Both the TSF and pipeline corridor

would be located on USFS lands. Due to topography and land constraints, NPAG and PAG tailings would need to be placed in separate impoundments. The PAG tailings would be placed and maintained unsaturated, and would be exposed to continual wetting and drying cycles associated with natural precipitation (average of 18 inches per year). This TSF alternative would be approximately 5,661 acres in size, and the ultimate embankment crests for NPAG and PAG would reach 1,040 feet and 750 feet in height, respectively.

The location of the Silver King TSF sits across the Concentrator, Main, and Conley Springs faults. It is predominantly underlain by Quaternary deposits overlaying Pinal Schist bedrock. A complex geologic sequence of Pinal Schist, Tertiary Gila Conglomerate, Mescal Limestone, Apache Group, Bolsa Quartzite, Dripping Spring Quartzite, and Tertiary Tuff occur along the southwestern portion of the TSF with Quartz Diorite occurring along the northeastern corner, all of which is covered by Quaternary deposits and incised with alluvial filled channels. Additionally, the Pinal Schist unit is known to have reduced strength along foliations which appear at the southeastern portion of the TSF (KCB 2018c).

The proposed Silver King TSF is situated at the northeast edge of the Superior Basin, which drains into Queen Creek and Potts Canyon and ultimately to the Whitlow Ranch Dam. Due to the topography, land constraints, and large volume of tailings, large diversion dams, underground tunnels, and pipelines would be required to reroute surface water from large upstream drainage basins, particularly from Comstock Wash and Whitford Canyon, around the TSF.

The Queen Creek aquifer in this area is relatively small with groundwater levels approximately 100 to 300 feet below the surface of the TSF. The three faults beneath the TSF are likely leaky barriers to groundwater flow, causing higher groundwater levels to the northeast of the faults (KCB 2018c). Seepage controls proposed for this alternative include the following (KCB 2018a, 2019):

Level 0

- Dewatering of tailings to 85-percent solids prior to placement in a dry-stack
- Underdrain system comprising a drainage blanket beneath the entirety of the compacted structural zone of the dry-stacked tailings

Level 1

- Lined channels downgradient of the tailings facility to direct captured seepage to the primary seepage collection system
- Primary seepage collection system in drainages surrounding the TSF comprising multiple lined seepage collection ponds, cutoff walls and pump-back wells to return the collected seepage
    - Cutoff walls will be excavated through the small amount of alluvium present, filled with compacted granular fill and grouted to competent bedrock

Level 2

- Targeted grouting of fractures in the foundation
- Pump back wells down gradient of the primary seepage collection cutoff walls

Seepage modeling studies determined that Levels 0 to 2 controls (KCB 2018a, 2019) would only reach 90 percent efficiency, leading to uncollected seepage rates of 9 AF/yr with Level 2 controls, which exceeds the preliminary modeled maximum allowable seepage of 6 AF/yr (Montgomery 2019a) needed to meet surface water quality standards at the POC identified for this alternative. As such, selenium is modeled to exceed surface water quality standards beginning in model year 59 (USFS 2019).

4.2.3.2. Practicability of Alternative

The Silver King TSF Alternative is not logistically or technologically practicable. While the land for this alternative is available, the dry-stack technology is not proven at this scale and seepage quantities are modeled to result in exceedances of surface water quality standards in downstream surface waters.

The current proven maximum throughput capacity for operating dry-stack facilities is approximately 20,000 tpd (at the La Coipa mine in Chile), or approximately 15 percent of the Resolution Copper Project's anticipated initial operating capacity of approximately 132,000 tpd. Most filtered tailings capacities in operation are less than 10,000 tpd. Furthermore, with land constraints and capacity requirements, the Silver King TSF would reach heights of 750 and 1,040 feet, both unprecedented heights for existing TSFs, in which structural stability is unknown. The embankment heights for the other proposed TSF alternatives for the project range between 200 and 520 feet in height.

As noted above, development of this alternative would result in concentrations of selenium above state-established surface water quality standards. In addition, seepage from this tailings facility would result in dissolved copper loading of Queen Creek, which has been determined to be impaired for copper by ADEQ. This alternative would increase the copper loading in Queen Creek by 11 to 21 percent, interfering with the state's efforts to reduce the loading in this impaired feature.

Additionally, the filtered tailings are placed partially saturated and exposed to the natural elements, an approach that goes against current BMP for PAG tailings that are highly pyritic and acid generating. Such designs are more prone to wetting and drying cycles than typical TSF systems, resulting in low pH and an increase in Total Dissolved Solids (TDS), as well as elevated metals in seepage during the LOM. Only the dry-stack is as affected by the cyclical wetting and drying that leads to oxidation.

Given the lack of demonstrated dry-stack technology at the scale contemplated by the project and seepage control issues, this alternative would not be considered logistically or technologically practicable. This alternative is not carried forward for further analysis.

4.2.4. Peg Leg TSF Alternative

4.2.4.1. Description

The Peg Leg TSF Alternative proposes the construction of two separate impoundments with a dual-embankment approach, a centerline embankment for containment of approximately 1.15 billion tons of NPAG tailings and a downstream embankment for containment of approximately 0.22 billion tons of PAG tailings capacity. These impoundments would be located on a mix of public lands managed by the BLM and State Trust lands that would need to be purchased from the ASLD prior to construction and operation of the TSF. The transportation corridor would be located on a combination of lands owned by the USFS, BLM, Bureau of Reclamation, Department of Defense, ASLD, and Resolution. Similar to Near West 'Dry', PAG tailings would be discharged sub-aqueously into a separate impoundment, a BMP for PAG tailings. However, with the Peg Leg TSF Alternative, the PAG facility would be contained behind a separate downstream embankment and separated into smaller operating cells to reduce pond size, seepage, and water required during the LOM (Golder 2018). These two impoundments would total approximately 10,782 acres in size with the ultimate height of the NPAG and PAG impoundments reaching 310 and 200 feet in height, respectively.

The Peg Leg TSF is underlain by exposed granitic bedrock towards the eastern portion of the site with younger alluvial deposits over a gently sloping bedrock pediment within the western half of the footprint (Golder 2018). Ruin Granite and Tea Cup Granodiorite are the main bedrock units in the eastern portion. The thickness of the unit varies widely within the area and has been noted that decomposed and unsolidified granite makes up the first 90 feet of depth. The granite bedrock units possess both low permeability ratings and high strength characteristics. The NPAG footprint is mainly on a mix of alluvial deposits that reach depths of as much as 2,000 feet.

The proposed Peg Leg TSF is adjacent to Donnelly Wash which drains ultimately into the Gila River. Stormwater diversion channels would be required for this TSF alternative. The aquifer is relatively large, and groundwater tests in the area reveal water elevation ranging from 50 feet below ground surface in the fractured bedrock aquifers to several hundred feet near the center of Donnelly Wash basin (Golder 2018).

The site's geology and hydrology make the application of cutoff walls and grout curtain technically infeasible, requiring a higher number of pump-back wells than the other TSF alternatives. The following levels of controls would be implemented for the Peg Leg TSF alternative (Golder 2018, KCB 2019):

Level 0

- Underdrain system comprising a drainage blanket beneath the entity of the embankment

Level 1

- Lined channels downgradient of the tailings facility to direct captured seepage to lined seepage collection ponds with pump-back wells
- Extension of embankment underdrains with fingers drains extending beneath the impoundment under the entire NPAG tailings beach area
- HDPE lining of the recycled water pond area
- Engineered low permeability layers for the entire PAG cell
- Extensive network of pumpback wells down gradient of the lined channels and ponds to form a continuous cone of depression below the NPAG embankment

Level 2

- Engineered low permeability liner for the entire PAG cell
- Excavation and removal of alluvium above the bedrock below PAG cells
- Utilization of thin lift deposition beginning when sufficient operating area becomes available
- Adjustments and refinements to the network of pump-back wells for seepage capture

Seepage modeling studies indicate that by implementing the Levels 0 to 2 seepage controls, this facility can obtain uncollected seepage rates of 261 AF/yr, which is equal to the allowable seepage of 261 AF/yr (Montgomery 2019a) modeled as necessary to meet surface water quality standards at the POC identified for this alternative. Modeling does not indicate that any constituents will occur in concentrations above established water quality standards as a result of tailings seepage. Currently, this alternative meets the allowable uncollected seepage rates with the Levels 0 to 2 seepage controls, and additional controls could be added. The location, geology, and distance to the Gila River allows for flexibility in implementing additional seepage control measures, if necessary.

4.2.4.2. Practicability of Alternative

The Peg Leg TSF Alternative is not practicable. While this alternative has the capacity to meet the project's purpose and is logistically and technologically practicable, the site is not available. The ASLD has indicated that this site is more suitable for future residential development and that it is not available for the use of a TSF. The area is relatively flat and in the vicinity of the limits of the Town of Florence. Since no configuration of this TSF alternative is available without encroachment onto ASLD or BOR withdrawn lands, this alternative is not available and thus impracticable. It is not carried forward for further analysis.

4.2.5. Skunk Camp TSF Alternative

4.2.5.1. Description

The Skunk Camp TSF Alternative is very similar to the Peg Leg TSF, with a dual embankment incorporating a robust centerline embankment for the NPAG tailings, and a downstream embankment for the PAG tailings. The TSF alternative is located on a mix of private and ASLD-managed State Trust

lands that would be purchased prior to construction and operation of the TSF. In contrast to the Peg Leg alternative, the ASLD has indicated that it is willing to consider the land at this location for development of a TSF. Two potential pipeline corridors are being analyzed for this TSF alternative: 1) the North Pipeline Corridor, and 2) the South Pipeline Corridor. Both would be located on USFS, private, and State Trust lands. The North Pipeline Corridor is currently the preferred corridor due to a smaller disturbance footprint, shorter length, lower required operating pressure, and lower pumping requirements. Impacts to the aquatic ecosystem and potential waters of the U.S. associated with the pipeline construction are anticipated to be largely temporary impacts and generally not material to the identification of the LEDPA.

The cross-valley design of the Skunk Camp TSF requires far less material to construct the embankment compared to three-sided ring-impoundment TSF designs needed at Near West and Peg Leg, thus reducing construction and operational complexity (KCB 2018d). Much like the Near West 'Dry' and Peg Leg TSF alternatives, the PAG tailings are physically isolated from the NPAG and are sub-aqueously placed into separate smaller operating cells located at the northern end of the NPAG tailings to reduce pond size, seepage, evaporative losses, and water required to maintain a water cover over the PAG tailings. The ultimate footprint would be approximately 4,002 acres in size with the ultimate height of the embankment crest reaching 490 feet in height.

The Skunk Camp TSF is situated along a north-trending normal fault and is underlain by a tertiary age Gila Conglomerate that is partially covered by Quaternary deposits, including alluvium in the base of the major valleys (KCB 2018d). There is some potential for relatively shallow Gila Conglomerate thickness west of the normal fault but greater depths along the eastern edge (Montgomery 2019a). Alluvial channels located throughout the site are considered pathways for groundwater flow and are noted to be less than 150 feet thick. Recent measurement of depth to groundwater taken within the alluvium and Gila Conglomerate, suggests that groundwater levels are approximately 70 feet below the ground surface in some locations (KCB 2018d).

This TSF alternative is located within the Dripping Spring Wash basin, which drains 13 miles to the southeast and discharges into the Gila River. Currently, several unnamed drainages report to Dripping Spring Wash. Stormwater diversion channels and dams are proposed on either side of the TSF, with one set of channels discharging into Dripping Spring Wash and the other set of channels diverting surface runoff into the upper reaches of Mineral Creek (SWCA 2018).

The site's geology and hydrology coupled with the overall design of the TSF allow for a less complex seepage collection system compared to the Near West 'Wet' and Near West 'Dry' TSF alternatives. The topography and geologic configuration of the site generally funnels seepage to one location, as compared to the topography and geologic configuration at Near West, which would allow seepage to move in multiple directions and thus require far more extensive engineering controls. This alternative would include only one cut-off wall, one grout curtain of far less length, and fewer pump-back wells.

For the Skunk Camp TSF, the differences in levels of seepage controls between Levels 1 and 3 are variations on the depth of the grout curtain and pump-back wells and not additional engineered controls. Seepage collection (KCB 2018d, 2019) for this TSF is summarized as follows:

Level 0

- Underdrain system comprising a drainage blanket beneath the entirety of the embankment

Level 1

- Extension of embankment underdrains beneath the entirety of the starter dam and into the impoundment between 100 and 200 feet under the NPAG tailings beach area
- Placement of an engineered low permeability layer for the PAG facility
- Seepage collection system including a lined seepage collection pond with a cutoff wall and pump-back wells to return and recycle the collected seepage
- Grout curtain to a depth of 70 feet
- Downgradient seepage pump-back wells to a depth of 20 feet

Level 2

- Extend Level 1 grout curtain to a depth of 100 feet
- Extend Level 1 downgradient seepage pump back wells to a depth of 70 feet

Level 3

- Extend Level 2 downgradient seepage pump back wells to a depth of 100 feet

Seepage modeling studies indicate that by using these Levels 0 to 3 seepage controls (KCB 2018d, 2019), this facility could obtain uncollected seepage rates of 65 to 178 AF/yr, which is well below the allowable maximum of 329 AF/yr (Montgomery 2019a) modeled as necessary to meet surface water quality standards at the POC identified for this alternative. No constituents were modeled to result in concentrations above established water quality standards.

4.2.5.2. Practicability

The Skunk Camp TSF Alternative is practicable. This alternative is available and both technically and logistically practicable. The ASLD has indicated that it is willing to sell this land to Resolution for the development of a TSF. The seepage collection system is simpler in design with a higher efficiency than the other TSF alternative designs, and there is substantial opportunity to implement additional seepage control measures for this alternative when compared to other alternatives. The design of the TSF under this alternative has the capacity to meet the overall project purpose.

Table 3. TSF Alternative Practicability Analysis Results Summary

TSF Alternative	Tailings Placement Method	Key Geologic and Hydrogeologic Characteristics	Available	Logistically Practicable	Technologically Practicable	Economically Practicable	Practicability Determination
Near West 'Wet'	Conventional thickened; modified centerline embankment.	Distance to Queen Creek is ~0.25 miles.	Yes	No	No – Significantly exceeds uncollected seepage maximums even with Level 4 controls.	Yes	**Not Practicable (technology and logistics)**
Near West 'Dry'	Ultra thickened NPAG; modified centerline embankment for NPAG; physically separated PAG cell using splitter berm.	Distance to Queen Creek is ~0.25 miles.	Yes	Yes	Yes – However, this TSF requires Level 4 seepage controls consistently operating at 99.5 percent efficiency. No known TSFs that use this degree of extensive seepage control technology to date.	Yes	**Practicable**
Silver King	Dry-stack NPAG and PAG; structural outer shell	Mix of diverse and complex geology with higher potential for weathering and fracturing. Requires extensive surface water diversion tunnels, dams, and channels.	Yes	No	No – Technology for dry-stack methodology at the scale needed to meet the project purpose has not been demonstrated, is at an unprecedented height, and lacks ability to meet water quality standards and secure an APP.	Yes	**Not Practicable (technology and logistics)**
Peg Leg	Ultra thickened NPAG; robust and resilient double embankment approach (full centerline for NPAG and downstream for PAG).	Geology is a mix of fractured bedrock for PAG and alluvial under NPAG. Distance to Gila River is ~2 miles.	No	Yes	Yes	Yes	**Not Practicable (not available)**
Skunk Camp	Ultra thickened NPAG; robust and resilient double embankment approach (full centerline for NPAG and downstream for PAG).	Geology is composed of Gila Conglomerate with thin alluvial cover. Distance to Gila River ~13 miles.	Yes	Yes	Yes	Yes	**Practicable**

5. ENVIRONMENTAL EFFECTS OF PRACTICABLE ALTERNATIVES

This section provides a comparative analysis of environmental impacts for those alternatives determined to be practicable in **Section 4**. This comparative analysis includes a discussion of impacts to the aquatic ecosystem and other anticipated adverse environmental consequences under each of the practicable alternatives. Identification of these other adverse environmental consequences is based on information contained in the baseline resource reports and DEIS prepared for Resolution's proposed mine development. Analyses of these other adverse environmental consequences are necessary to ensure that the Corps may identify the LEDPA, as required by the Guidelines (40 CFR § 230.10(a)).

The 404(b)(1) alternatives analysis is intended to ensure that no discharge be permitted "if there is a practicable alternative to the proposed discharge which would have less adverse impact on the aquatic ecosystem, so long as the alternative does not have other significant adverse environmental consequences" (40 CFR § 230.10(a)). The aquatic ecosystem, in turn, is defined as waters of the U.S., including wetlands, that serve as habitat for interrelated and interacting communities and populations of plants and animals (40 C.F.R. § 230.3(c)). In evaluating practicable alternatives, the Guidelines' preliminary focus is thus on assessing effects on waters of the U.S., but the analysis can extend to other adverse environmental consequences occurring outside of waters of the U.S.

The definition of "waters of the U.S." has been a source of considerable confusion for many years, particularly since the United States Supreme Court's 2006 decisions in *Rapanos v. United States and Carabell v. United States*. Following those decisions, the Environmental Protection Agency (EPA) and the Corps issued interpretive guidance, last modified in December 2008. In this 2008 CWA guidance document, entitled *Clean Water Act Jurisdiction Following the U.S. Supreme Court's Decision in Rapanos v. United States and Carabell v. United States* (the Guidebook), non-navigable tributaries that are not relatively permanent (which represent the majority of features present at all of the TSF alternatives) can be found jurisdictional only if they have a significant nexus with a Traditional Navigable Water (TNW). This represented a significant departure from the prior agency interpretation, which categorically regulated all tributaries, even ephemeral tributaries.

On June 29, 2015, the Corps and EPA adopted a new rule defining waters of the U.S. The new rule returned to a more categorical regulation of tributaries, including ephemeral tributaries. However, implementation of the 2015 rule is currently enjoined in 28 states, including Arizona, while being effective in 22 other states. That injunction is not permanent, and there is a chance that the 2015 rule could become effective in Arizona at some point.

Meanwhile, EPA and the Corps have proposed to repeal the 2015 rule, and separately proposed in early 2019 a new definition of waters of the U.S. that would exclude ephemeral features from regulation as waters of the U.S. Under the newly proposed definition, however, ephemeral features could serve as point sources if they conveyed pollutants to a regulated water, even if the ephemeral feature itself is not considered to be a water of the U.S.

In this analysis, identification of waters of the U.S. (or potential waters of the U.S.) is based on the 2008 Guidebook, which is still applicable in Arizona. Under the Guidebook, no waters of the U.S. exist in the footprint of the Near West alternatives (analyzed as Alternatives 2 and 3 in the DEIS), based on an approved jurisdictional determination issued by the Corps (SPL 2014-00064-MWL), but potential waters of the U.S. are believed to exist at the Skunk Camp alternative location (analyzed as Alternatives 6 in the DEIS), although no jurisdictional determination has yet been completed by the Corps. However, during the pendency of the Corps' review of Resolution's Section 404 permit application, the governing law on waters of the U.S. may change by the time the permit is issued. Were the 2015 rule to become effective in Arizona, ephemeral features at Near West and Skunk Camp would likely be considered jurisdictional; by contrast, if the 2019 proposed rule were adopted as proposed, neither site would likely contain any jurisdictional waters.

Given the uncertainty of whether ephemeral features within the footprints of the two practicable TSF alternatives could be considered jurisdictional waters of the U.S., the evaluation provided in this section focuses on impacts more broadly, informed by an evaluation completed by WestLand (2018) in support of the development of the DEIS. The evaluation that follows focuses on the extent of the OHWM in ephemeral systems (washes and ponds) and the location and extent of other aquatic features, such as seeps and springs. The identification of OHWM for the remaining practicable alternatives is based on a desktop review of high-quality, recent aerial photographs supplemented by field verification through collection of geolocated ground photography. The identification of seeps and springs was completed via review of U.S. Geological Survey topographic maps and other publicly available data, supplemented by full field inventory of the Near West (DEIS Alternatives 2 and 3) and Skunk Camp (DEIS Alternative 6) alternatives (Montgomery & WestLand 2017). Even if these features are not jurisdictional waters of the U.S. because they lack a "significant nexus" with a downstream TNW, they still provide wildlife habitat and other benefits (i.e., they still serve as "habitat for interrelated and interacting communities and populations of plants and animals"). Even if not waters of the U.S. (and thus not part of the "aquatic ecosystem" as defined in the Guidelines), impacts to these features can be considered other significant adverse environmental consequences, and thus may be considered in identifying the LEDPA.

5.1. Near West 'Dry' TSF Alternative

5.1.1. Impacts to the Aquatic Ecosystem and Surface Water Features

The estimated total impacts to surface water features and waters of the U.S. associated with this alternative (TSF footprint, pipelines, and associated facilities) are provided in **Table 4** and depicted in **Figure 6**.

Table 4. Near West 'Dry' TSF Alternative Impacts to Aquatic Ecosystem and Surface Water Features

Feature Type	Impact Area (ac)	
	Surface Water Features	Waters of the U.S.
Ephemeral features	36.89	0
Wetlands	0.2	0
Total Impacts	**36.89**	**0**

Aquatic Ecosystem and Surface Water Resources

The Near West 'Dry' TSF Alternative, located in the Queen Creek watershed, contains ephemeral drainages that possess an OHWM, but have been previously determined non-jurisdictional by the Corps. The ephemeral channels within the site and pipeline corridor contain functions and values typical of desert ephemeral systems. In addition to the ephemeral wash systems, three springs (Bear Tank Canyon, Benson, and Perlite springs) have been identified within the TSF footprint. While not jurisdictional, these features have wetland (i.e., special aquatic site) characteristics and have a cultural value to local tribes. Wetland features are particularly rare and valuable in arid areas.

5.1.2. Other Adverse Environmental Consequences

Identification of the other adverse environmental consequences of the development of Near West 'Dry' TSF Alternative is based on information contained in the baseline resource reports and DEIS. Focus is only on those resource effects which substantially distinguish one practicable alternative from the others. These adverse environmental consequences are compared to those of the other practicable TSF Alternatives to determine if selection of an alternative other than that identified as LEDPA is warranted (40 CFR §230.10(a)). As noted above, these other adverse environmental consequences include direct and indirect effects of the project on resources other than the aquatic ecosystem.

Environmentally damaging effects include the loss of surface water resources, including wetlands, within the footprint of Near West 'Dry' TSF Alternative, even if those resources do not constitute jurisdictional waters of the U.S. In addition, construction of the TSF under this alternative will directly affect approximately 3,308 acres of previously undisturbed National Forest System Lands.

Seepage Potential

This alternative is sited on a foundation comprised of bedrock incised with narrow channels infilled with alluvial, colluvial, and undifferentiated sediments. The relatively small Queen Creek alluvial aquifer lies approximately 50 feet below the surface, with Queen Creek less than 0.25 miles from the TSF. Whitlow Ranch Dam occurs approximately three miles downstream. The ring impoundment would produce seepage along all three sides. The extensive combined Levels 0 to 4 seepage controls, which go well beyond the typical copper porphyry TSF, would be required to meet ADEQ's surface water quality standards in Queen Creek and at Whitlow Ranch Dam. Uncaptured seepage would reach

the ground surface at Queen Creek and travel downgradient to Whitlow Ranch Dam. Groundwater modeling studies for this location indicate a preliminary maximum allowable of uncaptured seepage rate of 3 AF/yr. By using the extensive Level 4 seepage control measures, modelled uncollected seepage rates are 2.7 AF/yr, just meeting the allowable uncaptured seepage rate, thereby requiring the extensive engineering controls to work at maximum efficiency with little to no room for error over the life of the mine and in post-closure.

Tailings Safety

As part of the evaluation of tailings alternatives, a failure modes analysis of each of the alternatives was conducted and included in the DEIS. For each failure mode, relevant protection measures and design features in line with best practice international standards and state and federal regulations were identified to prevent the failure. The USFS then completed an effects analysis of potential tailings dam failures using the Rico Empirical Method; see Section 3.10.1.2 of the DEIS (USFS 2019). This evaluation method represents a "worst case" scenario as it does not consider embankment type, design features used to address failure modes, foundation conditions, or operational approaches.

As noted above, the Near West 'Dry' TSF Alternative has been designed with a modified-centerline embankment, which is inherently more resilient than upstream-type embankments, but less resilient to any accumulated missteps or unforeseen events than true centerline-type embankments. For this alternative, the embankment is required to extend to three sides of the facility, is generally free-standing and not anchored to consolidated rock, and as such is the longest of the embankments proposed (10 miles). These design features are not inherently unsafe, but are potentially less resilient than a shorter, well-anchored embankment.

An estimated 600,000 people are in the modeled potential area of effect should a tailings dam failure occur at this alternative. Given the proximity of the community of Queen Valley to the alternative location, there would be relatively little time for an evacuation. An estimated eight water supply systems, serving approximately 700,000 people, would be adversely impacted by such a failure, as would significant agricultural irrigation and water supply infrastructure, such as the Central Arizona Project (CAP) and other canals. Impact to the CAP canal would have the potential to disrupt water supplies well beyond the tailings failure flow path, as the City of Tucson and other communities rely heavily on CAP water.

Visual Resources

This alternative would be visible from U.S. Highway 60, Superior, and Queen Creek, which are located 1.7 miles to the south, 4.5 miles to the southeast, and approximately 3 miles southwest of the TSF, respectively. Because this alternative has a more prominent dam height than the Skunk Camp TSF alternative, and it is located proximal to the public, it would have substantially greater visual impacts than the Skunk Camp TSF alternative.

Recreation

The Arizona National Scenic Trail (AZT), an 800-mile trail system that covers the length of the state, passes approximately 0.75 miles east of the Near West 'Dry' TSF alternative site, through Rice Water Canyon and Whitford Canyon. The pipeline corridor and access roads associated with the Near West 'Dry' alternative would cross the AZT, affecting the users experience and potential becoming a safety concern with mining vehicles crossing a remote hiking trail. Being National Forest System lands, this alternative's location also contains highly used public recreation areas, such as hiking, which would be impacted by the construction of this alternative.

5.1.3. Compliance with the Guidelines

As previously described, a demonstration of compliance with the Guidelines at 40 CFR § Part 230 is required before a Section 404 permit may be issued for a project. The analysis of alternatives included in this practicability analysis document and made final in the Corps's 404(b)(1) alternatives analysis document is intended to facilitate compliance with 40 CFR § Part 230.10(a) that no discharge of dredged or fill material be permitted if there is a practicable alternative to the proposed discharge that would have less impact on the aquatic ecosystem, so long as the alternative does not have other significant adverse environmental consequences. The information on the range of alternatives analyzed, the availability and/or practicability of analyzed alternatives, the impacts to the aquatic system of the practicable alternatives, and the other significant adverse environmental consequences of the practicable alternatives described herein is intended to provide the Corps with the information necessary to make this determination under 40 CFR § Part 230.10(a).

The Guidelines also contain three other independent requirements at 40 CFR § Parts 230.10(b), (c), and (d) that must be met prior to the decision by the Corps to issue a permit. The requirement at 40 CFR § Part 230.10(b) prohibits discharges that will result in a violation of water quality standards or toxic effluent standards, will jeopardize a threatened or endangered species, or violate requirements imposed to protect a marine sanctuary. Operation of the TSF under the Near West 'Dry' alternative will require that Resolution obtain an APP from ADEQ, which requires the mine facility to demonstrate that it will not cause or contribute to an exceedance of AWQS at the point of compliance, or, if AWQS for a pollutant has been exceeded in an aquifer at the time of permit issuance, that no additional degradation will occur [A.R.S. § 49-243(B)(2)-(3); AAC R18-9-A202(A)(8)(a)]. Seepage must also not contribute to the exceedance of any ADEQ surface water quality standards where groundwater may emerge and contribute to surface flow [AAC R18-11-405(b)]. The extensive seepage control measures and control efficiencies required to meet this standard for the Near West 'Dry' alternative are described above; as discussed therein, 99.5-percent seepage capture efficiency, a standard not seen at any known TSF, is required to avoid causing an exceedance of surface water quality standards in Queen Creek.

As described in the DEIS (USFS 2019), the Near West 'Dry' alternative is not anticipated to jeopardize the continued existence of species listed as threatened or endangered under the Endangered Species Act (ESA) or result in the destruction or adverse modification of such species' designated critical habitat. The Near West 'Dry' alternative also will not violate any requirement designed to protect a marine sanctuary.

The requirement at 40 CFR § Part 230.10(c) prohibits discharges that will cause or contribute to significant degradation of jurisdictional waters of the U.S. Although not jurisdictional waters of the U.S., the discharge of fill for the construction and operation of the TSF will result in the loss of the structure and aquatic function of the ephemeral drainages and groundwater-dependent wetland ecosystems within the footprint of fill. As described above, the extensive seepage control measures and control efficiencies necessary for the Near West TSF to meet AWQS under the APP are intended to prevent significant adverse effects from seepage.

Other indirect and cumulative effects from the discharge on the aquatic environment are anticipated to be minimal and will not cause significant degradation. There are not anticipated to be significantly adverse effects on human health or welfare, on life stages of aquatic life and other wildlife dependent on aquatic ecosystems, or on aquatic ecosystem diversity, productivity and stability. There will be some indirect effect on recreational, aesthetic, and economic values of the lands surrounding the TSF as disclosed in the DEIS, but these effects are not significant adverse effects to or significant degradation of recreational, aesthetic, and economic values of the waters of the U.S. that result from the construction and operation of the TSF.

The requirement at 40 CFR § Part 230.10(d) prohibits discharges unless all appropriate and practicable steps have been taken to minimize potential adverse impacts of the discharge on the aquatic ecosystem. The development of the TSF design included a significant effort to avoid and minimize impacts to the ephemeral drainages and groundwater-dependent ecosystems in the area of the TSF. Although the area beneath the footprint of the TSF and its appurtenant features will no longer contribute runoff from precipitation to downstream drainage reaches, the TSF design minimizes impacts to downstream waters of the U.S. by diverting upstream stormwater flows around the facility. Similarly, the stormwater controls, run-on diversions, and engineering controls have been designed to maintain downstream stormwater flows while minimizing the risk of contaminant discharge to downstream surface water features to the maximum extent practicable.

5.2. Skunk Camp TSF Alternative

5.2.1. Impacts to the Aquatic Ecosystem and Surface Water Features

The estimated total impacts to surface water features and potential waters of the U.S. associated with this alternative (TSF footprint, pipelines, and associated facilities) are provided in **Table 5** and depicted in **Figures 7a and 7b**.

Table 5. Skunk Camp TSF Alternative Impacts to Aquatic Ecosystem and Surface Water Features

Feature Type	Impact Area (ac)	
	Surface Water Features	Potential Waters of the U.S.
Ephemeral Features	153.4	126.2
Wetlands	0	0
Total Impacts	**153.4**	**126.2**

Aquatic Ecosystem and Surface Water Resources

Potentially jurisdictional waters of the U.S. were mapped on the Skunk Camp TSF site using a recent ESRI Online aerial imagery analysis. Field reconnaissance and geolocated ground photography were used to further refine the delineation of OHWM characteristics. Potential waters identified within the site and pipeline corridor are dominated by both relatively confined and braided ephemeral channels with functions and values typical of desert ephemeral systems. No special aquatic sites (e.g., wetlands) or seeps and springs are located within the footprint of this TSF or either potential pipeline corridor.

5.2.2. Other Adverse Environmental Consequences

As indicated in **Section 5**, identification of the other adverse environmental consequences of the development of Skunk Camp TSF Alternative is based on information contained in the baseline resource reports and DEIS prepared for the proposed project.

Adverse direct effects include the loss of those resources within the footprint of Skunk Camp TSF Alternative. Construction of the TSF and associated infrastructure (including pipelines) under this alternative will directly affect approximately 4,002 acres of previously undisturbed private and state lands.

Seepage

This alternative's required seepage controls are much less extensive than the Near West 'Dry' TSF due to the foundation being located on less complex geology comprising Gila Conglomerate overlain with alluvial sediments. The cross-valley impoundment, located within a basin, allows for seepage to a singular point downgradient of the TSF. Groundwater modeling studies conducted indicate a preliminary maximum allowable of uncaptured seepage to be 329 AF/yr. Seepage control measure of a Level 3 indicate uncollected seepage rates of 65 to 178 AF/yr, which is below the maximum allowable by 46 to 80.3 percent.

Tailings Safety

A number of design and location considerations differentiate the Skunk Camp TSF Alternative from the Near West 'Dry' TSF Alternative. First, the embankment for the Skunk Camp TSF Alternative uses a cross-valley construction, which would have a single face instead of three faces and would be tied into consolidated rock on either end. In addition to being anchored to consolidated rock, the

embankment face would be considerably shorter—3 linear miles compared to 10. While the embankments for both alternatives would be designed to the same safety standards, the simpler construction of the Skunk Camp TSF Alternative embankment, combined with the ability to implement a dual-embankment approach (a full centerline embankment for NPAG; downstream embankment for PAG) would be considered more resilient to any accumulated missteps or unforeseen events. The design for this tailings alternative also effectively isolates the PAG material with a downstream embankment, making it less likely that these materials would be released in the event of a tailings failure.

Downstream communities potentially affected by the modeled dam failure total approximately 3,000 people and the larger population centers (Winkelman, Hayden, and Kearney) are over 20 miles downstream of the TSF, allowing adequate time for evacuation, if necessary. Four water supply systems, serving approximately 3,000 people, are downstream of the TSF and would potentially be affected by a tailings failure.

Visual Resources

This alterative is not highly visible from towns, cities, or densely populated areas.

Recreation

The Skunk Camp TSF Alternative is relatively remote and would not include National Forest System lands within the TSF footprint. The location of this TSF sees less recreational use compared to the Near West 'Dry' TSF Alternative. No known hiking trails (including the AZT) or recreational areas would need to be relocated due to the construction of this TSF alternative.

5.2.3. Compliance with the Guidelines

The information on the range of alternatives analyzed, the availability and/or practicability of analyzed alternatives, the impacts to the aquatic system of the practicable alternatives, and the other significant adverse environmental consequences of the practicable alternatives described herein is intended to provide the Corps with the information necessary to make the determination of LEDPA under 40 CFR § Part 230.10(a). The following section is intended to demonstrate the compliance of the Skunk Camp TSF alternative with the other three independent requirements at 40 CFR § Parts 230.10(b), (c), and (d) that must be met prior to the decision by the Corps to issue a permit.

The requirement at 40 CFR § Part 230.10(b) prohibits discharges that will result in a violation of water quality standards or toxic effluent standards, will jeopardize a threatened or endangered species, or violate requirements imposed to protect a marine sanctuary. As with the Near West 'Dry' alternative, the Skunk Camp TSF alternative requires an APP from ADEQ to demonstrate that it will not cause or contribute to an exceedance of AWQS at the point of compliance, or, if, AWQS for a pollutant has been exceeded in an aquifer at the time of permit issuance, that no additional degradation will occur [A.R.S. § 49-243(B)(2)-(3); AAC R18-9-A202(A)(8)(a)]. Seepage must also not

contribute to the exceedance of any ADEQ surface water quality standards where groundwater may emerge and contribute to surface flow [AAC R18-11-405(b)]. The seepage control measures and control efficiencies required to meet this standard for the Skunk Camp TSF alternative are described above. It is anticipated that seepage control using recognized technologies will be well above what is required to meet surface water quality standards.

As described in the DEIS (USFS 2019), the Skunk Camp TSF alternative is not anticipated to jeopardize the continued existence of species listed as threatened or endangered under the ESA or result in the destruction or adverse modification of such species' designated critical habitat. The Skunk Camp TSF alternative also will not violate any requirement designed to protect a marine sanctuary.

The requirement at 40 CFR § Part 230.10(c) prohibits discharges that will cause or contribute to significant degradation of jurisdictional waters of the U.S. The discharge of fill for the construction and operation of the TSF will result in the loss of the structure and aquatic function of the jurisdictional waters of the U.S., comprised entirely of ephemeral drainages, within the footprint of fill. Indirect and cumulative effects from the discharge on the aquatic environment are anticipated to be minimal and will not cause significant degradation. There are not anticipated to be significantly adverse effects on human health or welfare, on life stages of aquatic life and other wildlife dependent on aquatic ecosystems, or on aquatic ecosystem diversity, productivity and stability. There will be some indirect effect on recreational, aesthetic, and economic values of the lands surrounding the TSF as disclosed in the DEIS, but these effects are not significant adverse effects to or significant degradation of recreational, aesthetic, and economic values of the waters of the U.S. that result from the construction and operation of the TSF.

The requirement at 40 CFR § Part 230.10(d) prohibits discharges unless all appropriate and practicable steps have been taken to minimize potential adverse impacts of the discharge on the aquatic ecosystem. The development of the TSF design included a significant effort to avoid and minimize impacts to the ephemeral drainages and groundwater-dependent ecosystems in the area of the TSF. Although the area beneath the footprint of the TSF and its appurtenant features will no longer contribute runoff from precipitation to downstream drainage reaches, the TSF design minimizes impacts to downstream waters of the U.S. by diverting upstream stormwater flows around the facility. The Skunk Camp TSF has been located relatively high in the watershed of Dripping Spring Wash, minimizing the size of the upgradient watershed for which stormwater must be managed. Similarly, the stormwater controls, run-on diversions, and engineering controls have been designed to maintain downstream stormwater flows while minimizing the risk of contaminant discharge to downstream surface water features to the maximum extent practicable.

6. SUMMARY AND CONCLUSIONS

While the Skunk Camp TSF Alternative has impacts to currently jurisdictional waters of the U.S., and greater impacts to surface water (ephemeral wash) resources generally, the other practicable alternative, Near West 'Dry', would result in other significant adverse environmental consequences that must be factored into a LEDPA determination. First and foremost, seepage control under the Near West 'Dry' alternative would require the implementation of a level of engineering controls well beyond that which has been implemented and typical for copper porphyry TSFs, and would require those controls to work almost perfectly for long periods of time, in order for seepage from the TSF not to result in a violation of water quality standards. By contrast, the Skunk Camp alternative, due to less complex geology and topography, allows for use of significantly less complex engineering controls that can more reliably be expected to function effectively for long periods of time. The modeled seepage using these simpler and more reliable controls is significantly below that required to meet water quality standards. Skunk Camp is also located significantly further from any major surface water feature (approximately 13 miles from the Gila River, compared to Near West 'Dry' being only 0.25 miles from Queen Creek), allowing for substantial opportunity to incorporate additional engineering controls (e.g., cutoff walls, grout curtains, etc.), should any be necessary.

Other significant adverse environmental consequences of the Near West 'Dry' alternative in comparison to the Skunk Camp alternative are as follows: 1) Near West 'Dry' would result in the loss of surface water features with wetland (special aquatic site) characteristics (none are present at Skunk Camp); 2) Near West 'Dry' design and location present more challenges and far greater impacts affecting the potential for and consequences of tailings failure; 3) Near West 'Dry' would adversely impact existing recreational uses to a much greater degree; 4) Near West 'Dry' would require relocation of a portion of the Arizona Trail; 5) Near West 'Dry' would have significantly greater visual resource impacts due to its greater proximity to populated and traveled areas; and 6) Near West 'Dry' would impact over 3,000 acres of National Forest Service System land, whereas Skunk Camp would impact under 100 acres (solely in the pipeline corridor).

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FIGURES

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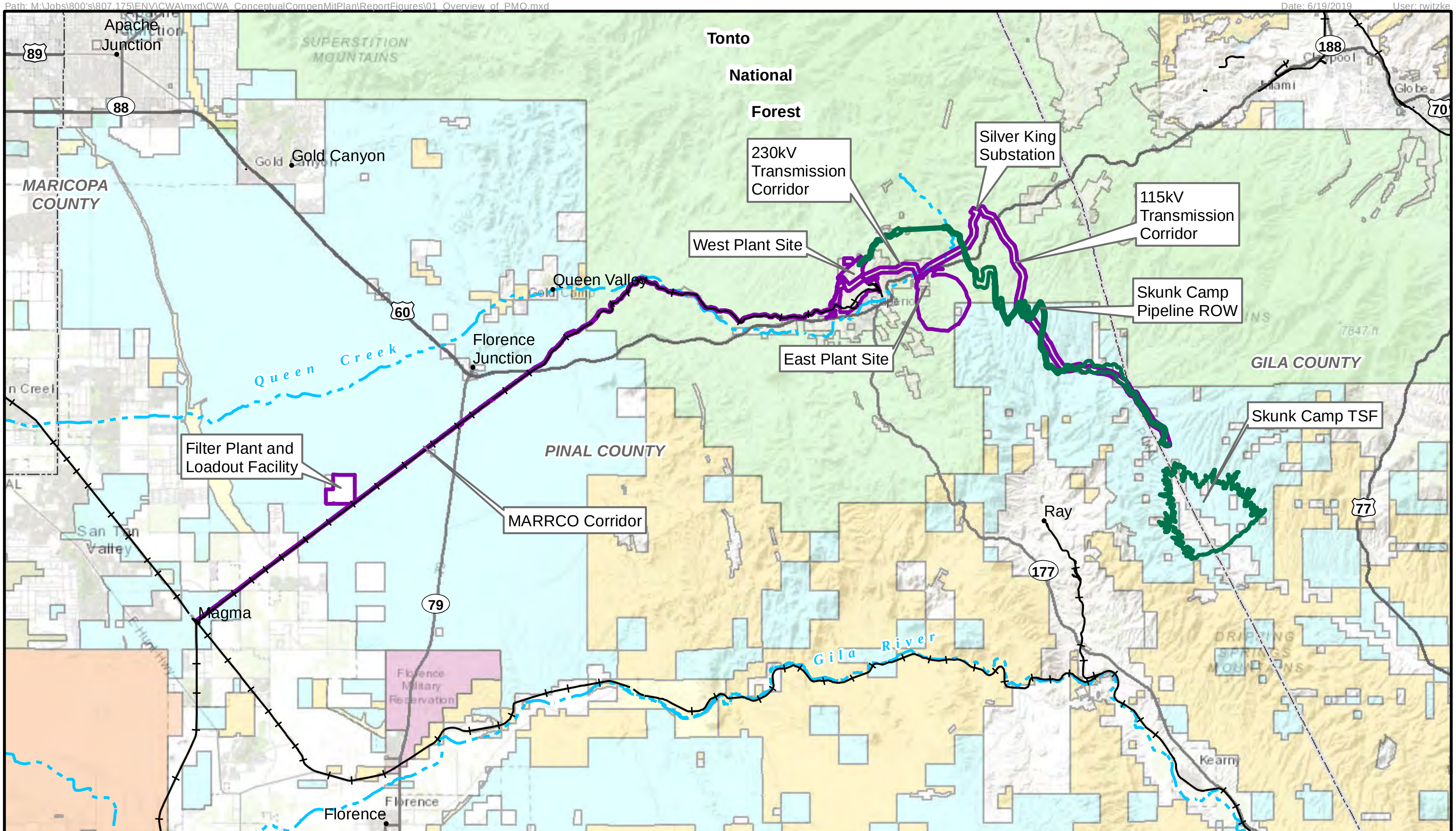

Pinal and Gila Counties, Arizona,
Data Source: BLM 2018, WRI Modified 2019,
ALRIS, SWCA, and USFS
Image Source: ArcGIS Online, World Topo Map

Legend

- Proposed Action
- GPO Mine Elements

Surface Management (BLM)

- County
- Indian Lands
- Local or State Parks
- Other
- State Trust Land
- Bureau of Land Management (BLM)
- Military
- Bureau of Reclamation
- Private Land
- US Forest Service (USFS)

N

0 2.5 5 Miles

0 4 8 Kilometers

WestLand Resources

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OVERVIEW OF
PROPOSED MINING OPERATION

Figure 1

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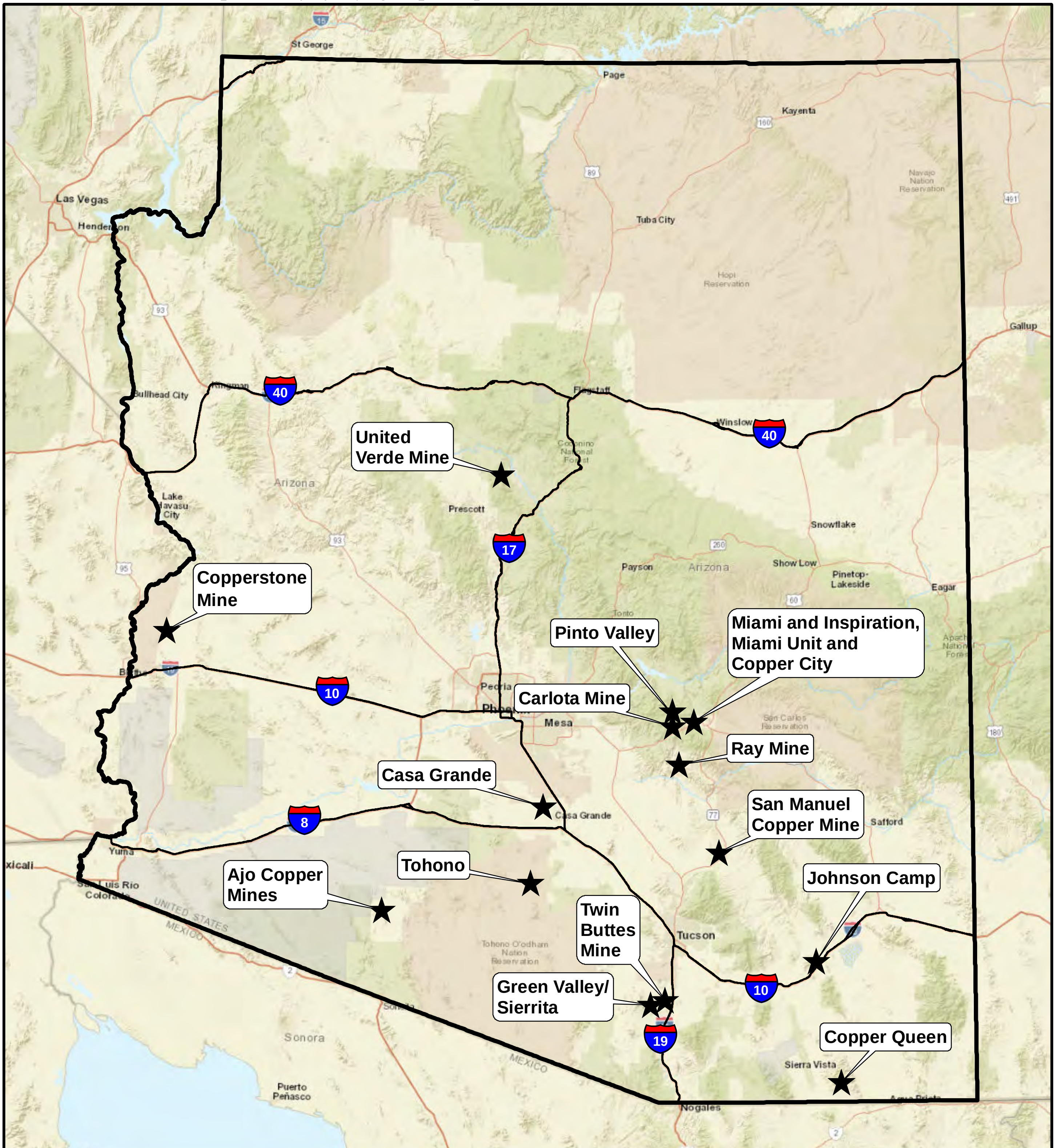

Data Source: ARLIS, USDA, USFS 11-1-2017
Image Source: ArcGIS Online World Street Map

Legend

★ Brownsfield Site

— Interstates (ALRIS)

N

0 25 50 Miles

0 50 100 Kilometers

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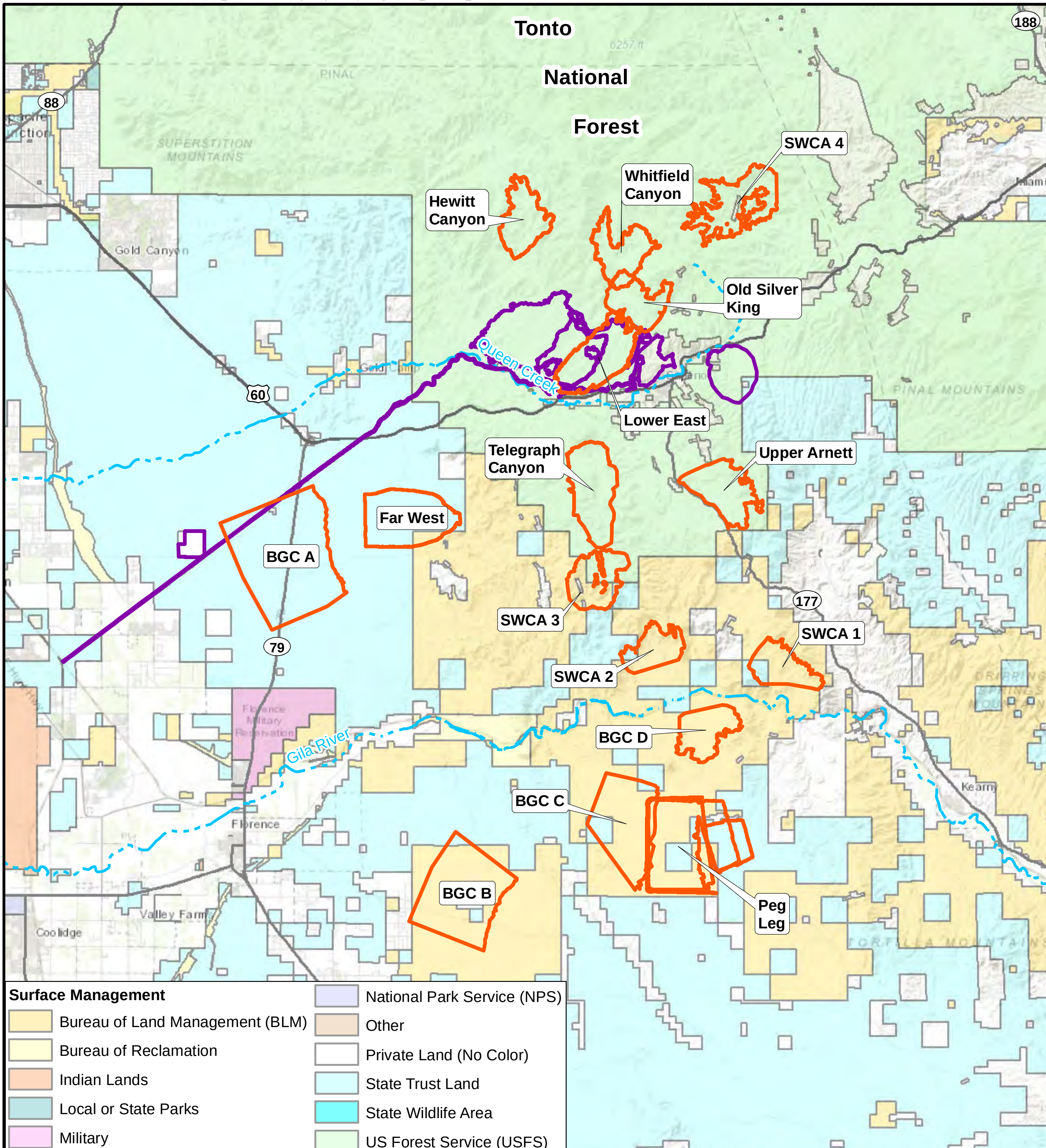
BROWNSFIELD TAILINGS STORAGE FACILITY LOCATIONS

Figure 2



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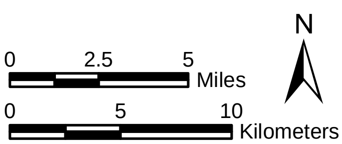

Legend

Tailings Alternatives Dismissed

Proposed Action

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INITIAL TAILINGS STORAGEFACILITY ALTERNATIVES DISMISSED FROM FURTHER CONSIDERATION

Figure 3

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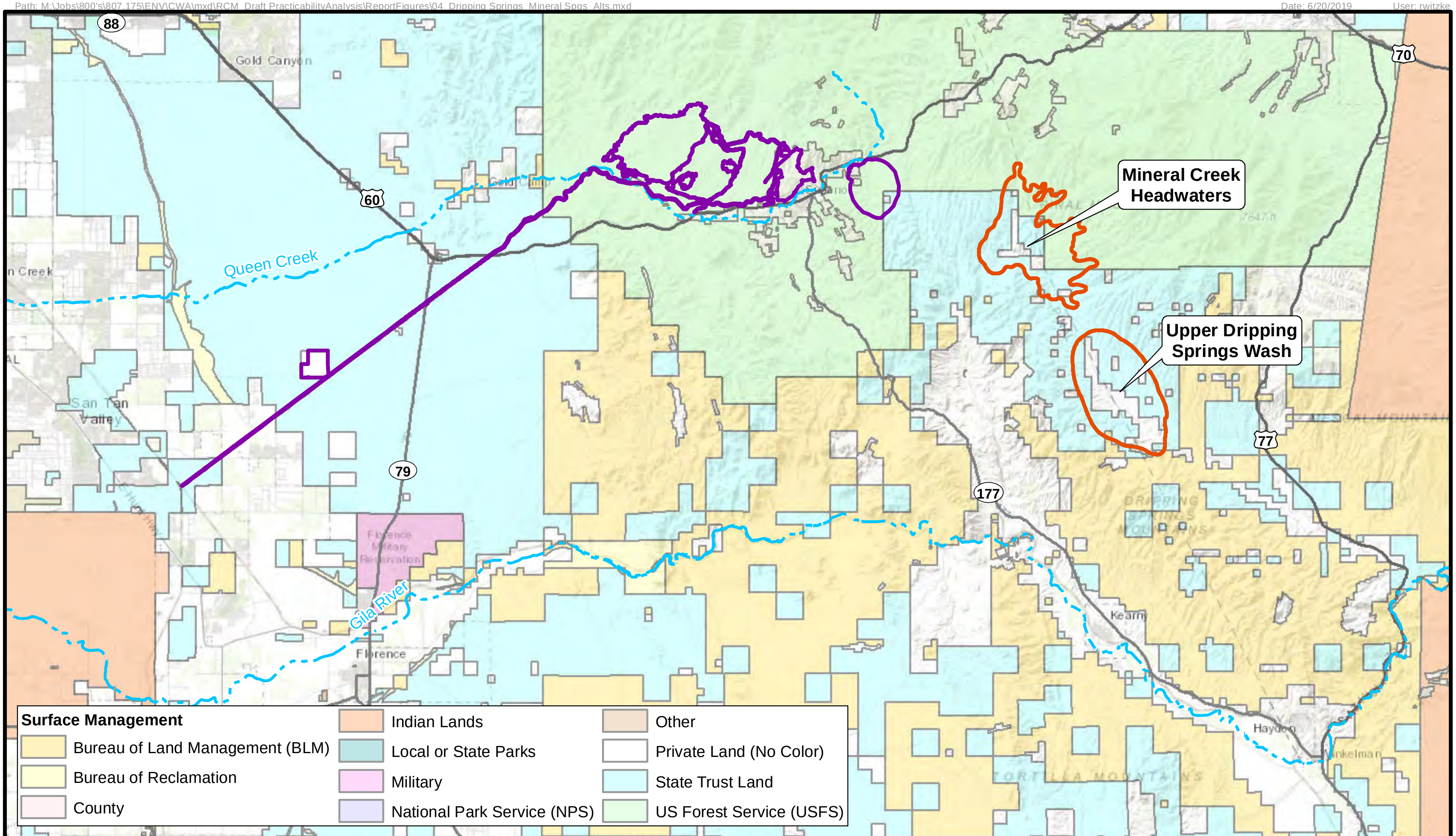

Data Source: 08-17-2018
Image Source: ArcGIS Online World Topo Map

0 2.5 5 Miles
0 5 10 Kilometers
N

WestLand Resources

Legend

Proposed Action

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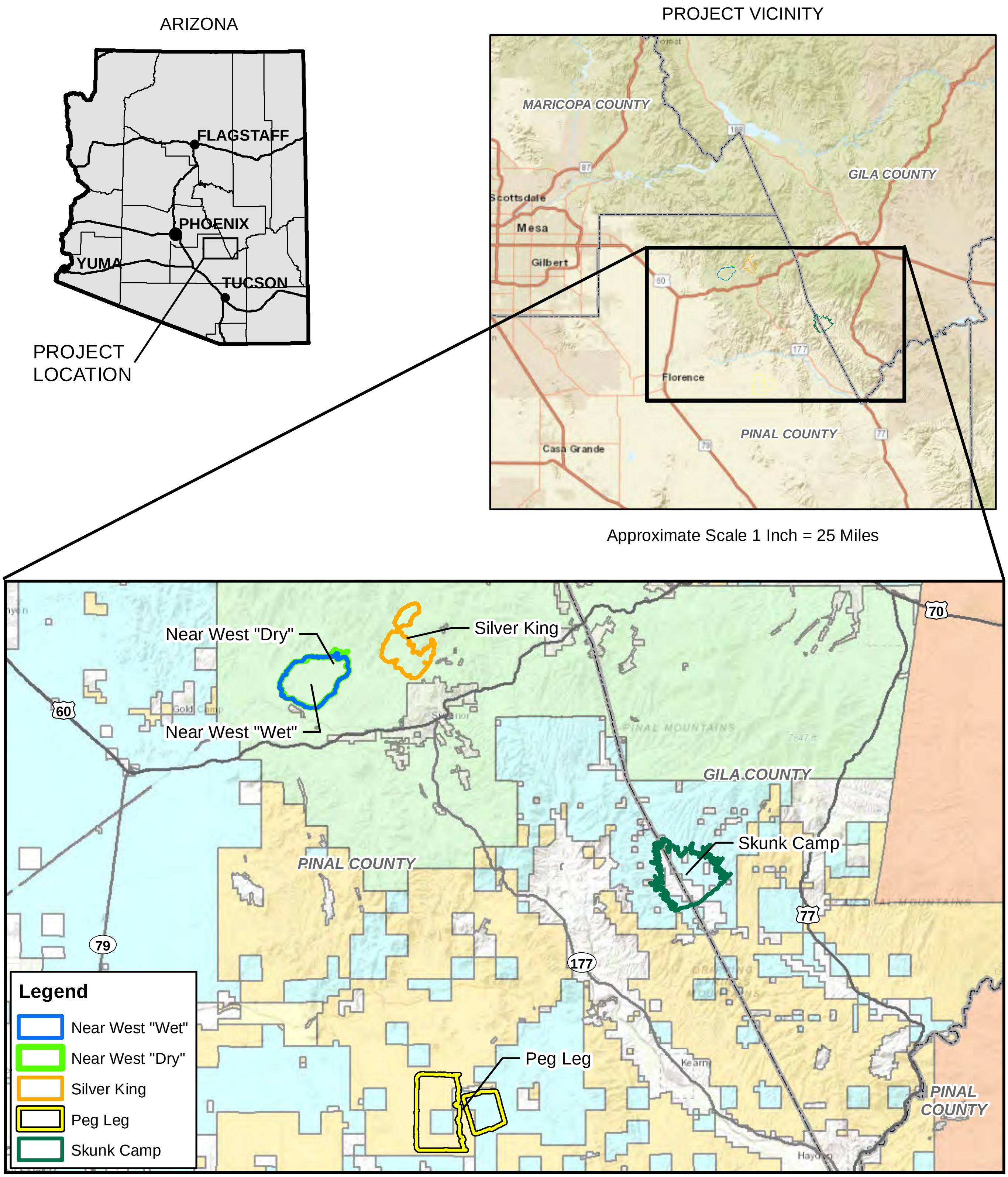
MINERAL CREEK AND UPPER DRIPPING SPRINGS ALTERNATIVES
Figure 4

Path: M:\Jobs\800's\807.175\ENV\CWA\mxd\RCM_Draft PracticabilityAnalysis\ReportFigures\05_OverviewTSF_AltLocations.mxd Date: 6/20/2019 User: rwitzke



Portions of T1S R11 and 12E; T2S R14E; T3S R14E;
T4S R12 and 13E; and T5S R12 and 13E,
Pinal and Gila Counties, Arizona,
Image Source: ArcGIS Online, World Topo and World Street Maps

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OVERVIEW OF TAILINGS STORAGE FACILITY ALTERNATIVES LOCATIONS CONSIDERED IN DETAIL

Figure 5

WestLand Resources

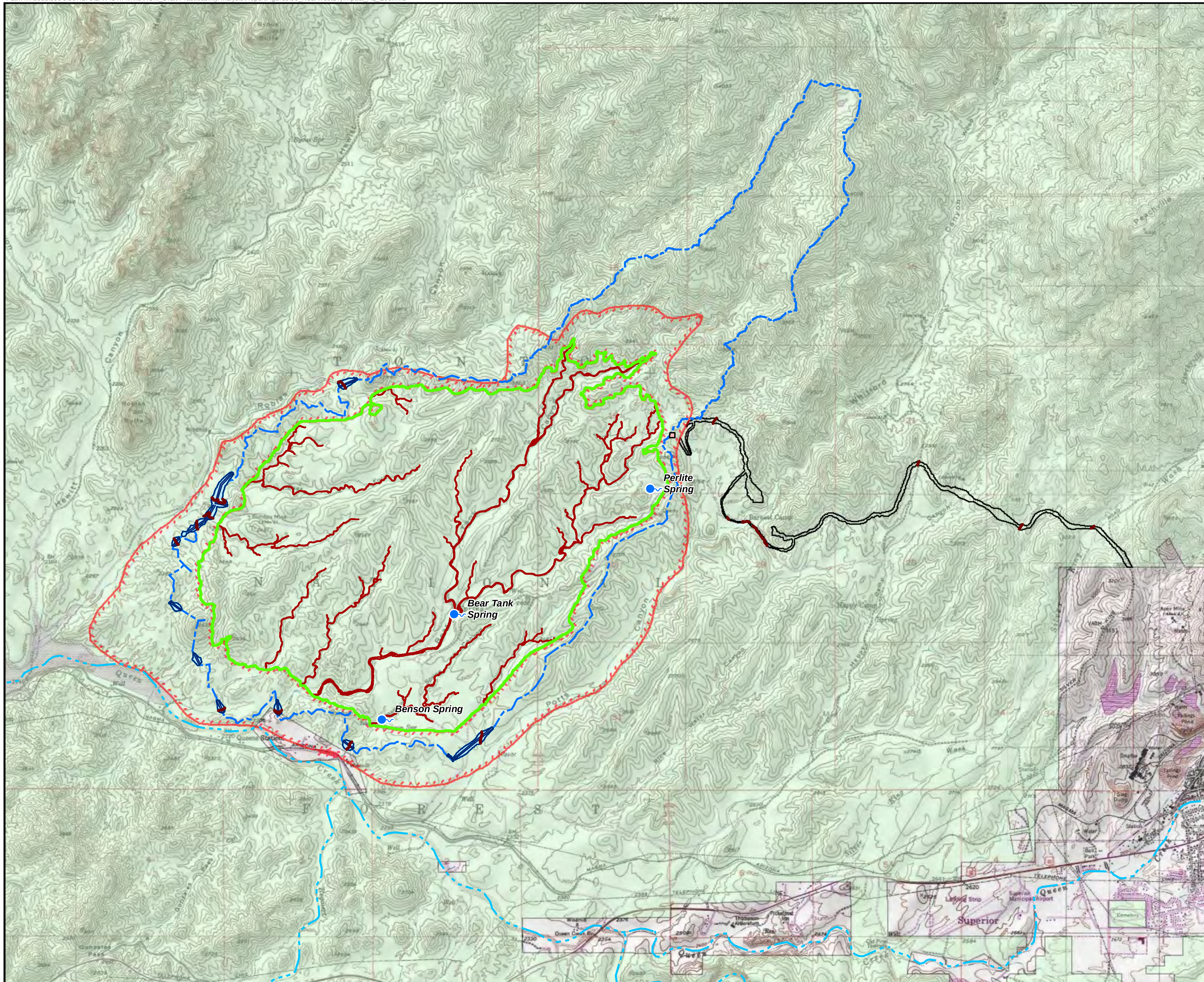
N

0 3 6 Miles

0 6 12 Kilometers

Path: M:\Jobs\800's\807.175\ENV\CWA\mxd\RCM_Draft PracticabilityAnalysis\ReportFigures\06_NearWestDryImpact_Aq_Eco.mxd

Date: 6/19/2019 User: rwitzke



Near West 'Dry' TSF within:
T1S, R11E, Portions of Sections 23-27, 34-36,
T1S, R12E, Portions of Sections 18, 19, 30, and 31,
Pinal County, Arizona,
Picketpost Mountain USGS 7.5' Quadrangle
Data Source: SWCA and Golder
Surface Management: BLM 2018, WRI modified 2019

Legend

- Spring (Montogermey & Assoc. 6-4-2018)
- Near West Seepage Dams
- Near West Dams
- Cyclone Plant
- Near West Catchment
- Near West 'Dry' Impacted Ordinary High Water Mark
- Near West 'Dry' Tailings Storage Facility
- Near West 'Dry' Tailings Corridor
- Proposed Fenceline

Surface Management (BLM)

- Private Land (No Color)
- US Forest Service (USFS)

N

0 1,750 3,500 Feet

0 600 1,200 Meters

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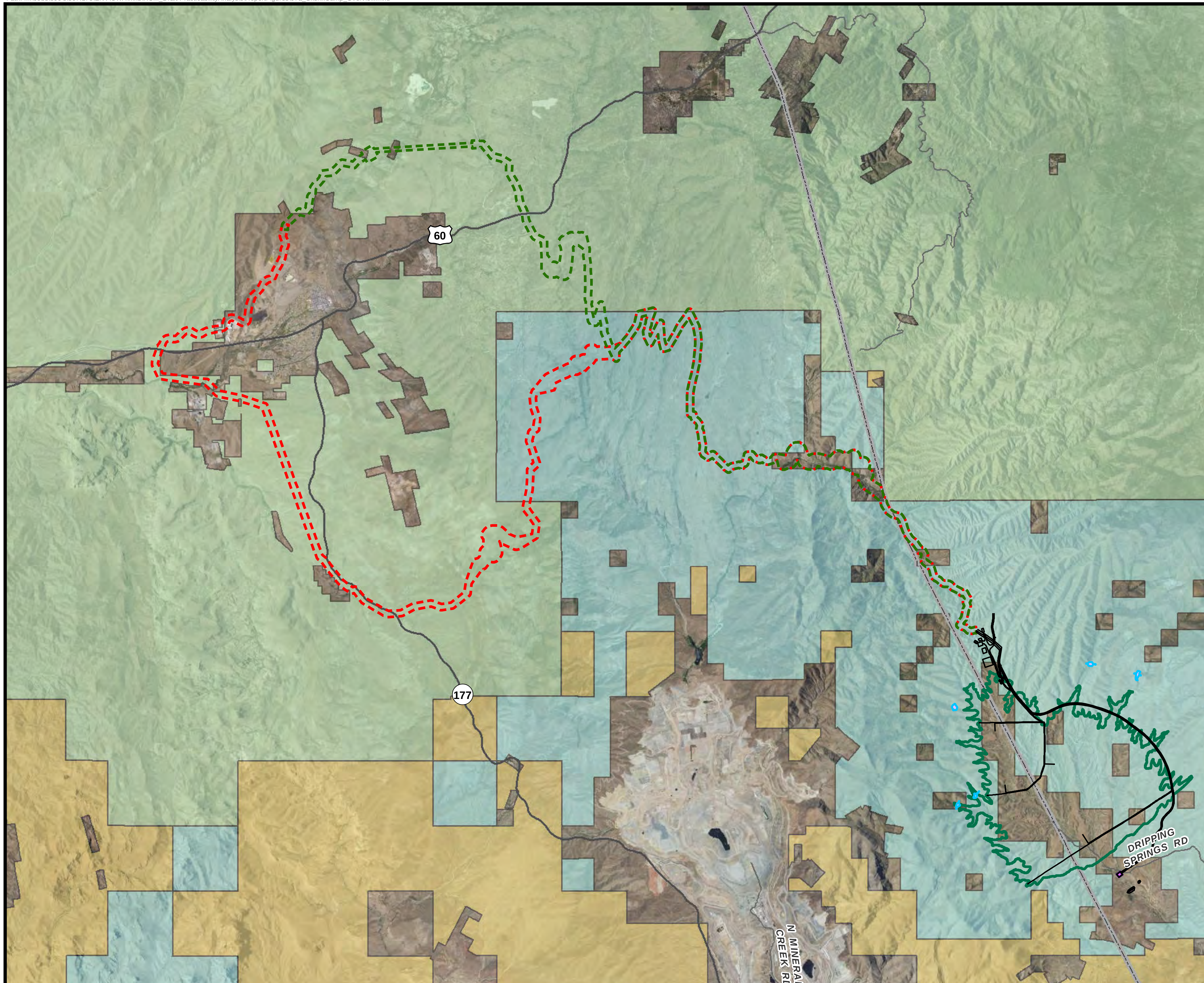
NEAR WEST 'DRY' IMPACTS TO AQUATIC ECOSYSTEMS

Figure 6

Path: M:\Jobs\800's\807.175\ENV\CWA\mxd\RCM_Draft PracticabilityAnalysis\ReportFigures\07a_SkunkCamp_Overview.mxd

Date: 6/19/2019 User: rwitzke



T1S, R12 and 13E, T2S, R12-14E, and T3S, R14E,
Gila and Pinal Counties, Arizona,
Data Sources: Golder and Associates, SWCA and RCM
Surface Management, BLM 2018, WRI modified 2019
Image Source: 2017 USDA NAIP Orthophoto

Legend

- Ancillary Facilities
- Skunk Camp Seepage Dam
- Skunk Camp Diversion Dyke
- Skunk Camp Toe Collection Pond
- Skunk Camp TSF
- North Skunk Camp 500 foot Pipeline ROW
- South Skunk Camp 500 foot Pipeline ROW

Surface Management

- Bureau of Land Management (BLM)
- Private Land (No Color)
- State Trust Land
- US Forest Service (USFS)

N

0 4,000 8,000 Feet

0 1,500 3,000 Meters

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SKUNK CAMP IMPACTS TO
AQUATIC ECOSYSTEMS OVERVIEW

Figure 7a

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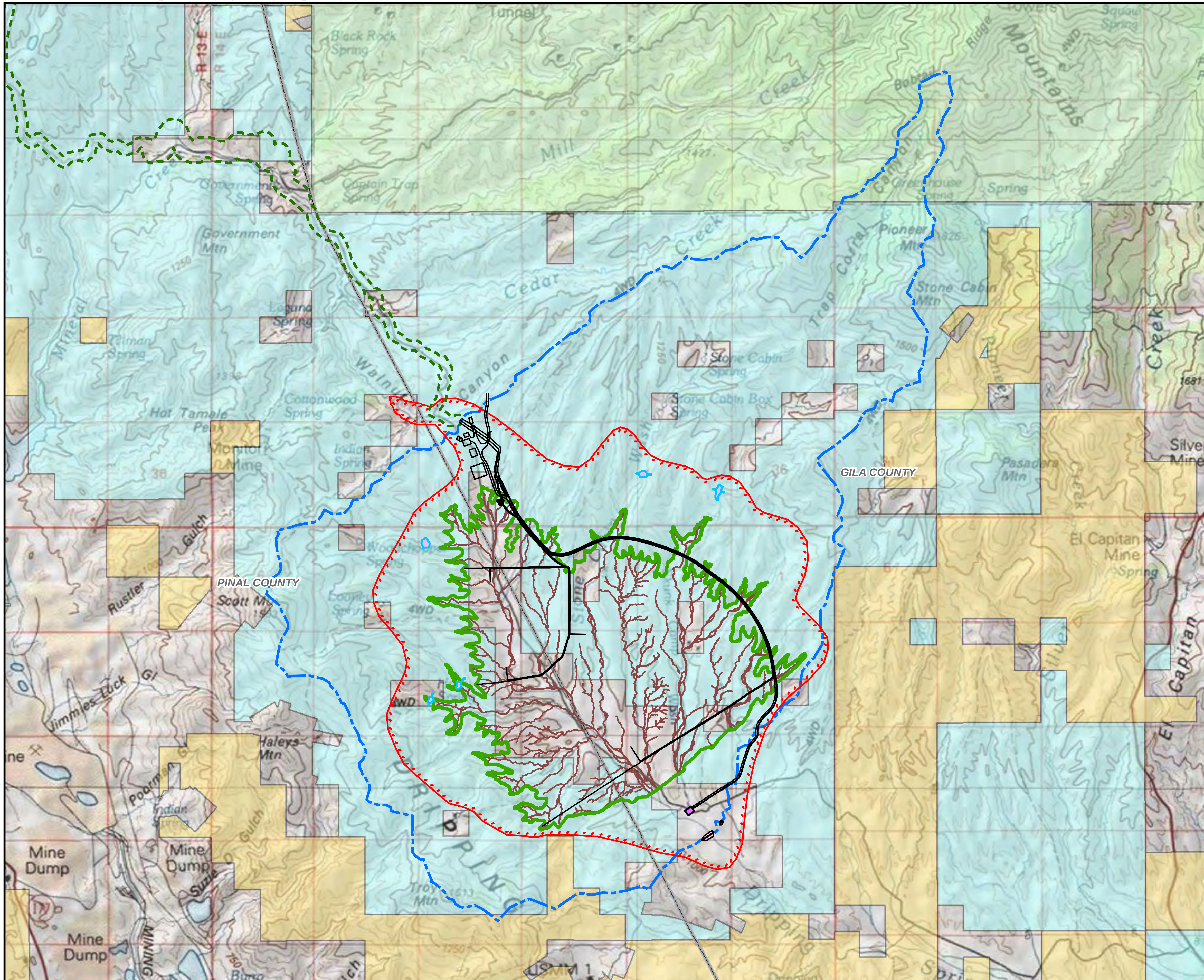
Date: 6/19/2019 User: rwitzke



Skunk Camp TSF within:
T2S, R14E, Portions of Sections 33-35,
T3S, R14E, Portions of Sections 1-4, 9-12, and 14-16,
Pinal and Gila Counties, Arizona,
Globe USGS 1:100,000 USGS Quadrangle
Surface Management: BLM 2018, WRI Modified 2018,
Data Source: Golder and SWCA

Legend

- Ancillary Facilities
- Skunk Camp Seepage Dam
- Skunk Camp Diversion Dyke
- Skunk Camp Toe Collection Pond
- Skunk Camp Impacted Ordinary High Water Mark
- North Skunk Camp 500 foot Pipeline ROW
- Proposed Fenceline
- Skunk Camp Catchment
- Skunk Camp Tailings Storage Facility

Surface Management (BLM)

- Bureau of Land Management (BLM)
- Private Land
- State Trust Land
- US Forest Service (USFS)

N

0 2,500 5,000 Feet

0 1,000 2,000 Meters

WestLand Resources

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SKUNK CAMP IMPACTS TO
AQUATIC ECOSYSTEMS
Figure 7b

APPENDIX A

Resolution Copper Mining, LLC Mine Plan of Operations and Land Exchange USFS Alternatives Data Request #3-F, Information on Potential Tailings Alternatives

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August 30, 2017

Ms. Mary Rasmussen
US Forest Service
Supervisor’s Office
2324 East McDowell Road
Phoenix, AZ 85006-2496

Subject: Resolution Copper Mining, LLC – Mine Plan of Operations and Land Exchange – USFS Alternatives Data Request #3-F, Information on Potential Tailings Alternatives

Dear Ms. Rasmussen,

In a letter Resolution Copper received from the USFS dated July 19, 2017 (Alternatives Data Request #3), the USFS requested Resolution Copper (RC) to provide information related to tailings storage facility concepts and locations. For your review and consideration, please find RC’s response to item F of that request listed below.

USFS Item F*: The Forest may consider tailings alternatives that would involve filtered tailings, more commonly known as "dry-stack" tailings. The Forest requests that Resolution provide input on technical or logistical concerns of using filtered tailings. We request that these specific topics be considered:*

1. *What technical or logistical limitations does Resolution foresee regarding the ultimate height or footprint of a filtered tailings facility, or regarding the proposed disposal rate (tonnage per day)?*

2. *What technical or logistical limitations does Resolution foresee regarding the distance that filtered tailings could be reasonably conveyed? Alternatively if tailings were instead pumped via pipeline as a slurry to a tailings disposal facility and then filtered at that location prior to stacking, what is the potential acreage or infrastructure that would be needed for the filter equipment?*

3. *What potential concerns does Resolution foresee with respect to controlling acid rock drainage if scavenger and pyrite/cleaner tailings are disposed in a filtered tailings facility?*

Resolution Copper Response to F:

RC has studied filtered tailings as a tailings management strategy and found that filtered tailings are not a beneficial, reasonable or practicable tailings management strategy for the Resolution

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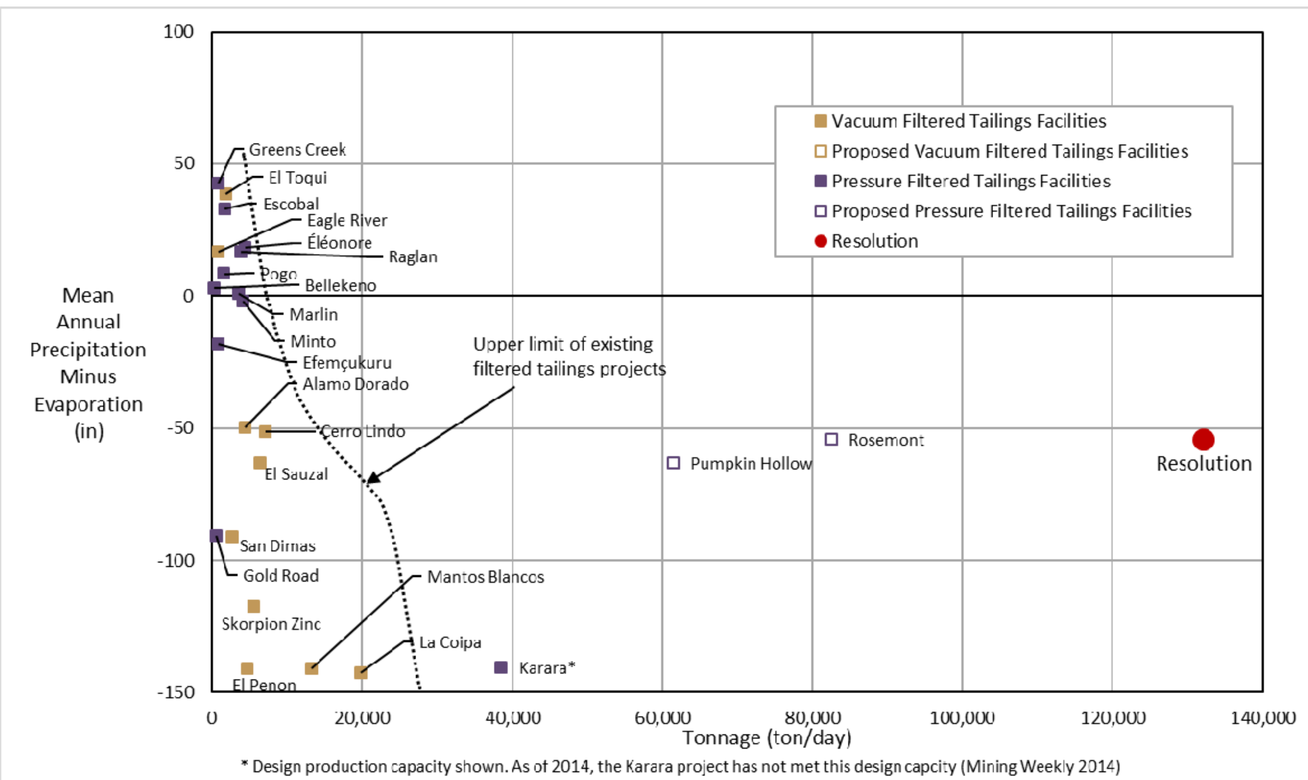
Project primarily because the scale is unprecedented and not demonstrated at an equivalent tonnage rate as well as other factors related to transportation, construction, water management and dust management challenges which are outlined herein.

RC has responded to each sub question of the Forest's item F separately below.

Resolution Copper Response to F-1: Technical and Logistical Limitations of Filtered Tailings for the Resolution Project

A key consideration when assessing the reasonableness, practicality and benefits of a tailings management strategy is precedents and lessons learned from case histories. A review of case histories was completed as part of the filtered tailings study, completed by RC's tailings engineer Klohn Crippen Berger, Ltd, whom have been involved with the Greens Creek filtered tailings facility for approximately 20 years and have been involved in several tailings technology reviews over recent years. An output from the review was a comparison of climate conditions to daily tailings production rate for operating mines and proposed projects, shown in Figure 1. The Resolution Project is also plotted on the figure for comparison.

Figure 1 Summary of Review Filtered Tailings Cases



Note: Net precipitation = mean annual precipitation minus mean annual evaporation. RC is in a semi-arid climate zone with low mean annual precipitation of 18 inches and high estimated mean annual potential evapotranspiration of 72 inches, for a mean annual precipitation minus evaporation of -54 inches per year.

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Based on the case history review of current and existing operations across the industry:

- Filtered tailings have never been applied at the production scale (130,000 ton per day) proposed for the Resolution Project or stored in a *dry-stack* pile of equivalent height.
    - Most filtered tailings are less than 10,000 tons per day. The La Coipa mine which is currently in care and maintenance did implement filtered tailings technology to a 20,000 tons per day operation. RC's estimated tailings production is 130,000 tons per day, 650% greater than La Copia.
    - Karara Mining Ltd. had proposed filtered tailings to manage a 40,000 ton per day operation, but returned to a conventional slurry facility after challenges with filtering and conveying limited production ramp-up.
    - To date, the maximum slope height of filtered embankments achieved is approximately 200 feet (La Coipa – from toe to crest, although maximum thickness of filtered tailings is approximately ~70 feet). A filtered tailings facility for the Resolution Project would be around 560 feet.

Given the vast differences between the tested and demonstrated limits of filtered tailings at the scale required for this project, RC will not consider this as a reasonable or practicable method for tailings management. In addition to precedents, additional key findings from RC's study of filtered tailings also are not in support of this tailings management strategy for this project, such as:

- Processing and Transportation
    - Most filtered tailings projects have reported challenges achieving target moisture contents and throughputs from filter plants on a reliable basis, especially at start-up. Conventional tailings facilities typically do not have this problem.
- Construction and Operations
    - Filtered tailings at the Near West site would be mechanically placed in rugged terrain which requires a significant construction fleet. The scale of the construction fleet for this operation would be much larger than a typical operation and be logistically challenging. See response to F-2 as well.
    - Due to potential upsets/unreliability of the filter plant and conveyor systems (i.e., mechanical break-downs, material produced at the filter plant that is too wet for transportation, flood events, wind events, etc.), multiple layers of back-up storage would be required (at the filter plant, at the filtered facility and potentially a separate back-up conventional tailings facility, like the Karara case history). At the Resolution Project's production rates, a back-up facility or stockpile would not be feasible within the current proposed disturbance footprints. Therefore, there would be significant additional disturbance on National Forest Service land.
- Water Management
    - Water management for filtered tailings for the Resolution Project would be complex. Runoff and seepage water would be managed in large external collection

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ponds rather than within the tailings impoundment as with conventional tailings facility. Therefore, there will be additional water retaining dams around the site, larger in size than those required for conventional slurry tailings options, and increased disturbance on National Forest Service land.

- Dust Management
  - Walking stacker conveyors for transporting and placement of filtered tailings would likely be required in a scenario for RC, a large active placement area is required, which cannot be progressively reclaimed. Therefore, there will be large areas requiring dust mitigation measures.
  - Unsaturated filtered tailings are prone to dusting and require active dust management if they can't be progressively reclaimed; requiring regular wetting, temporary covers, or some other measures to suppress dust (such as polymer suppressants).
  - Conventional slurry tailings facilities (as proposed in the mine plan of operations) would also have large exposed areas, but are more easily managed with multiple spigots to maintain a wet beach to reduce dust creation.
  - Due to the lower water content of the filtered tailings, more water (or other measures) would need to be used for dust mitigation than for conventional slurry. If water sprinklers are used as the dust management methodology, the make-up water benefits from using filtered tailings in comparison to conventional slurry tailings will be lessened significantly.

Resolution Copper Response to F-2: Transportation Logistics Considerations and Filter Plant Size

Due to the difficulty in transporting filtered tailings in comparison to slurry, it is not practical to have the filter plant at the WPS. The filter plant would be located at the tailings site, increasing the disturbance of National Forest Service lands. For this scale of operation, a filter plant would have a footprint of approximately 10 acres based on an estimate of the number of filter presses required. Once filtered, the tailings then require transportation to the tailings site and placement. Filter tailings can be transported via trucks or conveyors.

Many projects transport filtered tailings with trucks. The highest production mine reviewed that is using trucks as the primary method of filtered tailings transportation was Cerro Lindo at 7,100 tons per day. RC would need to place 130,000 tons per day. At 20 tons per load, RCM would require 6,500 dump truck loads per day to be moved from the filter plant to the tailings facility for placement. This method of placement would not be reasonable or practicable and therefore, walking stacker conveyors would be used for transportation, plus equipment to spread and compact the tailings. The rough terrain at the Near West site and at potential alternative locations would require the use of conveyors before valleys are filled, which is exceedingly difficult because walking stacker conveyors don't walk on rough rugged steep terrain and therefore re-handling of the tailings is likely required (additional earth-moving equipment). The substantial amount of

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heavy equipment would contribute significant amounts of noise and emissions above what is normal for conventional tailings facilities.

Resolution Copper Response to F-3: Acid Rock Drainage (ARD) Management

RC ore processing will generate two mineralogically and geochemically discrete tailings streams known as "scavenger" tailings and "cleaner" (or pyrite) tailings. Pyrite tailings are classified as Potentially Acid Generating (PAG). The management approach per the mine plan of operations for pyrite tailings involves subaqueous placement during operations (submerged beneath the reclaim pond) and then progressive covering with a thick sequence of scavenger tailings which would limit oxygen and thus minimize acid rock drainage.

If the pyrite tailings were filtered and stacked, they would be placed and kept in an unsaturated state. Thus, will oxidize under wetting and drying cycles from storm events, which would generate ARD and produce poorer water quality runoff compared to pyrite tailings stored in a saturated state (e.g. beneath a pond in a conventional facility). In a submittal to the USFS dated March 9, 2017 Resolution Copper provided a detailed technical report evaluating the chemistry of unsaturated pyrite tailings. The report is titled "*Geochemical Reactivity of Unsaturated Pyrite Tailings Technical Memorandum*" and included in Attachment 4 of this submittal.

As described in the response to F-1 above, external water management facilities are required to manage the water that can't be stored on the tailings surface. These can be large depending on topography, operational water balance, and storm storage requirements. In the case of the proposed location in the mine plan of operations, a filtered tailings scenario would require external water management facilities containing poor quality contact storm water to be located closer to Queen Creek.

Should you have any questions or require further information please contact me.

Sincerely,

Vicky Peacey

Vicky Peacey,
Senior Manager, Permitting and Approvals; Resolution Copper Company, as Manager of Resolution Copper Mining, LLC

Cc: Ms. Mary Morissette, Senior Environmental Specialist; Resolution Copper Company
Mr. Andrew Luke, Metallurgical Engineer; Resolution Copper Company
Ms. Kate Patterson, P.Eng., M.Eng., PE, Associate, Tailings and Water Resources Engineer, Klohn Crippen Berger, Ltd

APPENDIX B

Tables 3.1 – 3.7
Adapted from
Klohn Crippen
Berger
(KCB) 2019

APPENDIX B. TABLES 3.1 – 3.7 ADAPTED FROM KLOHN CRIPPEN BERGER
SUMMARY OF DEIS TAILINGS ALTERNATIVES SEEPAGE CONTROL LEVELS
(Section 3, Pages 2 – 11, February 22, 2019)

Table 3.1 TSF Alternatives References

TSF Alternative	Seepage Control Design for Draft EIS	Uncaptured Seepage Estimate
2 Near West ("wet")	KCB (2018a)	M&A (2018b, 2019)
3 Near West ("dry")	KCB (2018b)	M&A (2018b, 2019)
4 Silver King	KCB (2018c)	KCB (2019b)
5 Peg Leg	Golder (2018a, 2018b)	Golder (2019)
6 Skunk Camp	KCB (2018d)	KCB (2019a)

Table 3.2 Summary of TSF Alternatives Seepage Control Levels

Seepage Control Measures	Alternative 2 Near West – "wet"				Alternative 3 Near West – "dry"				Alternative 4 Silver King Filtered		Alternative 5 Peg Leg		Alternative 6 Skunk Camp		
Seepage Control Level:	1	2	3	4	1	2	3	4	1	2	1	2	1	2	3
Discharge control systems to achieve BADCT for base metal TSFs (ADEQ 2005)															
Storm water and shallow aquifer intercepts	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Natural geologic features functioning as liners	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓			
Localized liners of geosynthetics and/or clay	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓
Fine Sealing	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓
Sub-drainage beneath the impoundment	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Leachate collection systems (finger or blanket drains)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Lining beneath main underdrains													✓	✓	✓
Centerline embankment construction	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓
Drains and reclaim water pump-back systems	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓
Free draining rockfill zones in the embankment															
Runoff water collection via channels and dikes or berms from embankment surface	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Engineered hydraulic barriers – grout curtains with pump-back wells	✓	✓	✓	✓	✓	✓	✓	✓		✓			✓	✓	✓
Engineered hydraulic barriers – reclaim wells and trench drains with clay or geomembrane				✓				✓					✓	✓	✓
Other seepage control measures															
Tailings thickening	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
High-density thickening of tailings (and implementation of thin lift placement)					✓	✓	✓	✓				✓			
Dewatering (filtering)									✓	✓					
Downgradient pump-back wells			✓	✓			✓	✓		✓	✓	✓	✓	✓	✓
Extended engineered hydraulic barriers – grout curtains with pump-back wells		✓	✓	✓		✓	✓	✓						✓	✓
Additional downgradient pump-back wells				✓				✓						✓	✓

Table 3.3 Alternative 2 Near West Modified Proposed Action (Modified Centerline Embankment – "wet") Seepage Control Levels

Level of Seepage Control	Seepage Control Description (see KCB 2018a)	From M&A (2018b, 2019)				
		Average Seepage Capture Efficiency (%) (Note 1)	Average Scavenger (NPAG) Seepage (acre-ft/yr)	Average Pyrite (PAG) Seepage (acre-ft/yr)	Average Collection Pond Seepage (acre-ft/yr)	Average Uncaptured Seepage (acre-ft/yr)
0	Features required for stability and act as seepage control features include modified centerline-raised compacted cycloned sand embankments and an embankment underdrainage system.	*not explicitly modeled*				
Between 0 and 1 (Note 2)	Seepage control measures represented in the 2018 Alternative 2/3 steady-state model report[2] (M&A 2018) include: ▪ features for stability described above; ▪ embankment underdrains extend into the impoundment under the entire scavenger beach; and ▪ seepage collection ponds with cut-offs walls and pump-back wells.	91%	1,912	220	8	194
1	Seepage control measures as presented in the DEIS report (KCB 2018a) include: ▪ features for stability described above; ▪ embankment underdrains extend into the impoundment for 200 ft; ▪ foundation treatment or selective engineered low-permeability layers in areas that are not Gila Conglomerate; ▪ engineered low-permeability layers for the pyrite starter facility; ▪ encapsulation of pyrite tailings in the scavenger tailings fines; and ▪ seepage collection ponds with cut-offs, grout curtains and pump-back wells. Grout curtain would extend from the ground surface to 100 ft below ground.	*not explicitly modeled*				
2	To increase Level 1 seepage capture, Level 2 (as described in KCB 2018a) includes extending the grout curtain to target high-permeability zones and seepage pathways.	*not explicitly modeled*				
3	To increase Level 2 seepage capture, Level 3 (as described in KCB 2018a) includes adding additional seepage collection ponds/facilities downstream.	*not explicitly modeled*				

Level of Seepage Control	Seepage Control Description (see KCB 2018a)	From M&A (2018b, 2019)				
		Average Seepage Capture Efficiency (%) (Note 1)	Average Scavenger (NPAG) Seepage (acre-ft/yr)	Average Pyrite (PAG) Seepage (acre-ft/yr)	Average Collection Pond Seepage (acre-ft/yr)	Average Uncaptured Seepage (acre-ft/yr)
4	To increase Level 3 seepage capture, Level 4 (as described in KCB 2018a) includes additional pump-back wells and grout curtain/cut-off walls. Seepage control measures represented in modified steady-state model report[2] (M&A 2019), in addition to the simulation described in M&A (2018), include: ▪ low-permeability liners in areas that are not Gila Conglomerate; ▪ engineered low-permeability liner for the entire pyrite cell; ▪ downgradient grout curtain extending from the ground surface to 100 ft below ground; and ▪ additional pump-back wells (see Note 3).	99%	1,910	223	0.6	21

Notes:

1. Seepage capture efficiency is calculated from the tailings seepage that enters the foundation, it does not account for dewatering (thickening/filtering) or climate effects.
2. Seepage control modeled by M&A were based on the seepage control measures described in KCB (2018a).
3. Pump back wells were added in the model by M&A in locations to maximize seepage capture.

Table 3.4 Alternative 3 Near West Modified Proposed Action (High-density thickened NPAG Scavenger and Segregated PAG Pyrite Cell) - Seepage Control Levels

Level of Seepage Control	Seepage Control Description (see KCB 2018b)	From M&A (2018b, 2019)				
		Average Seepage Capture Efficiency (%) (Note 1)	Average Scavenger (NPAG) Seepage (acre-ft/yr)	Average Pyrite (PAG) Seepage (acre-ft/yr)	Average Collection Pond Seepage (acre-ft/yr)	Average Uncaptured Seepage (acre-ft/yr)
0	Features required for stability and act as seepage control features include modified centerline-raised compacted cycloned sand embankments and an embankment underdrainage system.	*not explicitly modeled*				
Between 0 and 1 (Note 2)	Seepage control measures represented in the steady-state model report[2] (M&A 2018) include: ▪ embankment underdrains extend into the impoundment under the entire scavenger beach; and ▪ seepage collection ponds with cut-offs walls and pump-back wells.	84%	508	220	5	116
1	Seepage control measures as presented in the DEIS report (KCB 2018a) include: ▪ features for stability described above; ▪ embankment underdrains extend into the impoundment under the entire scavenger beach; ▪ foundation treatment or selective engineered low-permeability layers in areas that are not Gila Conglomerate; ▪ engineered low-permeability layers for the entire pyrite cell; and ▪ seepage collection ponds with cut-offs, grout curtains and pump-back wells. Grout curtain would extend from the ground surface to 100 ft below ground.	*not explicitly modeled*				
2	To increase Level 1 seepage capture, Level 2 (as described in KCB 2018b) includes extending the grout curtain to target high-permeability zones and seepage pathways.	*not explicitly modeled*				
3	To increase Level 2 seepage capture, Level 3 (as described in KCB 2018b) includes adding additional seepage collection ponds/facilities downstream.	*not explicitly modeled*				

Level of Seepage Control	Seepage Control Description (see KCB 2018b)	From M&A (2018b, 2019)				
		Average Seepage Capture Efficiency (%) (Note 1)	Average Scavenger (NPAG) Seepage (acre-ft/yr)	Average Pyrite (PAG) Seepage (acre-ft/yr)	Average Collection Pond Seepage (acre-ft/yr)	Average Uncaptured Seepage (acre-ft/yr)
4	To increase Level 3 seepage capture, Level 4 (as described in KCB 2018b) includes additional pump-back wells and grout curtain/cut-off walls. Seepage control measures as represented in modified steady-state model report (M&A 2019), in addition to the simulation described in M&A (2018), include: ▪ selective engineered low-permeability liners in areas that are not Gila Conglomerate; ▪ engineered low-permeability liners for the entire pyrite cell; ▪ grout curtain would extend from the ground surface to 100 ft below ground, extending to target high-permeability zones and seepage pathways; and ▪ additional pump-back wells (see Note 3).	99.5%	630	130	15	3

Notes:

1. Seepage capture efficiency is calculated from the tailings seepage that enters the foundation, it does not account for dewatering (thickening/filtering) or climate effects.
2. Seepage control modeled by M&A were based on the seepage control measures described in KCB (2018b).
3. Pump back wells were added in the model by M&A in locations to maximize seepage capture.

Table 3.5 Alternative 4 Silver King Seepage Control Levels

Level of Seepage Control	Seepage Control Description (see KCB 2018c, 2019b)	Average Seepage Capture Efficiency (%) (Note 1)	Average Scavenger (NPAG) Seepage (acre-ft/yr)	Average Pyrite (PAG) Seepage (acre-ft/yr)	Average Collection Pond Seepage (acre-ft/yr)	Average Uncaptured Seepage (acre-ft/yr)
0	Features required for stability and act as seepage control features include dewatered tailings, compacted structural zone with an underdrainage system.	n/a	77.5	1.9	0.6	n/a
1	In addition to the features for stability, seepage collection, as presented in the DEIS report (KCB 2018c), includes lined collection ditches and collection ponds that cut-off the alluvium. There is potential that a portion of the seepage would not be collected with this approach. A preliminary estimate of up to 80% capture is assumed because seepage can be collected in the underdrains and the alluvial channels will be cut-off. There is a remaining risk that a large portion of the flow paths would bypass seepage collection.	less than 80%				greater than 17 acre-ft/yr
2	In addition to the features described for Level 1, additional seepage control measures would include targeted grouting of fractures (potential seepage pathways) in the foundation and pump-back wells for seepage return. A preliminary estimate of up to 90% capture is assumed because of the uncertainty in the foundation conditions. There is a remaining risk that a portion of the flow paths would bypass seepage collection.	up to 90%				greater than 9 acre-ft/yr

Notes:

1. Seepage capture efficiency is calculated from the tailings seepage that enters the foundation, it does not account for dewatering (thickening/filtering) or climate effects.

Table 3.6 Alternative 5 Peg Leg Seepage Control Levels

Level of Seepage Control	Seepage Control Description (see Golder 2018a, 2018b, 2019)	Average Seepage Capture Efficiency (%) (Note 1)	Average Scavenger (NPAG) Seepage (acre-ft/yr)	Average Pyrite (PAG) Seepage (acre-ft/yr)	Average Collection Pond Seepage (acre-ft/yr)	Average Uncaptured Seepage (acre-ft/yr)
0	Features required for stability and to act as seepage control features include modified centerline-raised compacted cycloned sand embankments and an embankment underdrainage system. Separate NPAG and PAG cells	n/a	2,660	1,270	<1	3,930
1	Seepage control measures as presented in the DEIS report (Golder 2019) include: ▪ features for stability described above; ▪ surface water diversions around the NPAG and PAG facilities to minimize run-on surface water; ▪ lined Seepage collection ponds and ditches; ▪ finger drains extending from the embankment underdrains below the impoundment beach and along the existing drainages; ▪ HDPE lining of reclaim pond area (300 acres) where reclaim pond is in contact with native materials; ▪ engineered low-permeability layers for the entire pyrite cell; and ▪ pump-back wells to form a continuous cone of depression (cut off) and collect surface seepage below the NPAG embankment.	65%	2,537	1,211	<1	1,317
2	Seepage control measures, as described above with the addition of: ▪ complete synthetic lining of PAG cells base and embankment; ▪ removal of alluvium and pervious sediments above bedrock below PAG cells; ▪ utilization of thin-lift deposition beginning in year 7 when sufficient operating area becomes available; and ▪ adjusting pump back wells to allow 261 acre-ft/yr to bypass system (requires less pumping than level 1).	84%	1,640	25	<1	261

Notes:

1. Seepage capture efficiency is calculated from the tailings seepage that enters the foundation, it does not account for dewatering (thickening/filtering) or climate effects.

Table 3.7 Alternative 6 Skunk Camp Seepage Control Levels

Level of Seepage Control	Seepage Control Description (see KCB 2018d, 2019a)	Average Seepage Capture Efficiency (%) (Note 1)	Average Scavenger (NPAG) Seepage (acre-ft/yr)	Average Pyrite (PAG) Seepage (acre-ft/yr)	Average Uncaptured Seepage (acre-ft/yr)
0	Features required for stability and also act as seepage control features include centerline-raised compacted cycloned sand embankments and an embankment underdrainage system.	n/a	1,820	50	n/a
1	Seepage control measures as presented in the DEIS report (KCB 2018d) include: ▪ features for stability described above; ▪ embankment underdrains extend into the impoundment for 100 ft to 200 ft; ▪ engineered low-permeability layers for the pyrite cells; ▪ seepage collection ponds with cut-offs, grout curtains and pump-back wells. Grout curtain would extend from the ground surface to 70 ft below ground and the seepage pump-back wells at 20 ft below ground level (estimated to be the base of the alluvium).	64%[1]	1,820	50	580-660
2	To increase Level 1 seepage capture, Level 2 (as described in KCB 2019) includes an extension of the grout curtain to 100 ft and the seepage pump-back wells installed at 70 ft below ground (estimated to be the base of the weathered Gila Conglomerate layer).	80%[1]	1,840	50	270-370
3	To increase Level 2 seepage capture, Level 3 (as described in KCB 2019) includes an installation of the seepage pump-back wells at 100 ft below ground, at the depth of the grout curtain.	90%[1]	1,840	50	70-180

Notes:

1. Seepage capture efficiency is calculated from the tailings seepage that enters the foundation, it does not account for dewatering (thickening/filtering) or climate effects.

APPENDIX D. RESOLUTION COPPER PROJECT CLEAN WATER ACT SECTION 404 CONCEPTUAL COMPENSATORY MITIGATION PLAN

DRAFT

RESOLUTION COPPER PROJECT CLEAN WATER ACT SECTION 404 CONCEPTUAL COMPENSATORY MITIGATION PLAN

Prepared for: Resolution Copper

Prepared by: WestLand Resources, Inc.

Date: June 21, 2019

Project No.: 807.175 03 03

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1. INTRODUCTION

Resolution Copper Mining, LLC (Resolution, or the Applicant) proposes to develop and operate an underground copper and molybdenum mine near Superior, Arizona. As proposed, the tailings storage facility (TSF), pipelines, and associated facilities require the discharge of fill to surface water features that the U.S. Army Corps of Engineers (Corps) is anticipated to determine to be potentially jurisdictional waters of the United States (waters of the U.S.) pursuant to a preliminary jurisdictional determination (PJD). Based on the presumption that potentially jurisdictional waters of the U.S. will be impacted by discharges of dredged or fill material resulting from portions of Resolution's planned mine development, Resolution will need to make an application for a Clean Water Act (CWA) Section 404 permit for these discharges.

In order to secure a CWA Section 404 permit, the Applicant is bound by the requirements of the Corps's and the U.S. Environmental Protection Agency's (EPA) "Final Rule for Compensatory Mitigation for Losses of Aquatic Resources" (33 C.F.R. Parts 325 and 332 and 40 C.F.R. Part 320; published in 73 Fed. Reg. 19594-19705) (Corps & EPA 2008), hereinafter referred to as the 2008 Mitigation Rule. The fundamental objective of the 2008 Mitigation Rule is to establish standardized compensatory mitigation criteria for all mitigation types to offset unavoidable impacts to waters of the U.S. authorized through the issuance of a CWA Section 404 permit. Compensatory mitigation is required after efforts to avoid and minimize impacts have been exhausted and impacts to waters of the U.S. would still occur. This conceptual compensatory mitigation plan introduces the suite of potential mitigation elements that Resolution will use to comply with the 2008 Mitigation Rule. A final conceptual mitigation plan will be developed once the extent of waters of the U.S. is confirmed and the magnitude of impacts (direct and indirect) have been refined. These mitigation measures will be evaluated as part of the National Environmental Policy Act (NEPA) evaluation being led by the U.S. Forest Service (USFS) with the Corps as a cooperating agency.

2. PROJECT DESCRIPTION

Resolution's planned mine development is located near Superior in Pinal County, Arizona (**Figure 1**) in an area called the Copper Triangle and specifically within the Pioneer Mining District. Mine exploration and operations have been conducted in the area since the early 1860's, when the discovery of silver led to the development of the Silver King Mine. Magma Copper Company (Magma) took over the Silver King Mine and operated it as the Magma Mine from 1912 until the concentrator was finally shut down in 1996. After Magma's shutdown, the Resolution ore deposit was discovered 1.2 miles south of the existing Magma Mine and 7,000 feet below the ground surface.

Resolution was formed as a limited liability company in 2004 by Rio Tinto and BHP Billiton. Rio Tinto is the managing entity and possesses a 55-percent ownership stake in Resolution, while BHP Billiton maintains 45-percent ownership. Since 2004, Resolution has steadily worked to investigate and delineate the Resolution ore body, develop a mine design, prepare environmental and engineering studies to support the mine permitting and approvals effort, and conduct multiple community

outreach efforts and public meetings to inform and involve the public as plans were developed. These efforts led to the submittal of a General Plan of Operations (GPO) to the USFS in November 2013, and the subsequent NEPA evaluation by the Corps and the USFS.

Resolution proposes the development of the Resolution ore body using panel caving, a type of block cave mining. The copper and molybdenum ore will be mined, undergo primary crushing underground, and then be sent to a newly constructed concentrator facility to be located at the existing WPS north of Superior. Concentrate produced here will be transported offsite for additional processing, while the resulting tailings will be transported via a tailings pipeline to the proposed TSF location. Under the current proposed operating conditions and Life of Mine (LOM) planning parameters, the Resolution ore body is sufficient to support the concentrator operations for approximately 41 years. As currently configured, operations are anticipated to result in the mining of approximately 1.4 billion tons of copper and molybdenum ore and the production of approximately 1.37 billion tons of tailings.

Through the alternatives analysis process under NEPA, the U.S. Forest Service (USFS) evaluated numerous geographic locations for tailings storage within an approximately 200-mile radius around the mine. The USFS evaluated both singular TSFs, where pyrite and scavenger tailings were stored together, and separate scavenger and pyrite TSFs, depending on the geophysical and hydrogeological setting. Additional factors included favorable topography and sufficient storage capacity. This information is detailed in Section 2 and Appendix B of the *Resolution Copper Project and Land Exchange Draft Environmental Impact Statement* (USFS 2019). The final alternatives selected for detailed analysis were those TSF designs that addressed the widest range of issues identified during public scoping and had the potential to be selected as the least environmentally damaging practicable alternative (LEDPA). This conceptual compensatory mitigation plan has been developed based on the assumption that the Corps could ultimately identify, from the range of alternatives evaluated in the DEIS, a TSF alternative that has impacts to jurisdictional waters of the U.S. as the LEDPA for the Resolution Project (WestLand 2019). The suite of potential mitigation elements described within this plan would then be used to comply with the 2008 Mitigation Rule. However, the mitigation elements described herein would be applicable to all the alternatives carried forward for consideration in the DEIS (USFS 2019) and the practicability analysis (WestLand 2019).

3. AVOIDANCE AND MINIMIZATION

The development of alternatives for Resolution's proposed underground copper and molybdenum mine design included a significant effort to avoid and minimize impacts to potential waters of the U.S. to the extent practicable. As described above, only certain alternative locations for the TSF, pipelines, and associated facilities analyzed in the practicability analysis have impacts to potential waters of the U.S. An exhaustive evaluation of TSF alternatives was completed by the USFS and cooperating agencies, including the Corps. This evaluation of alternatives included other existing mine, or brownfields, sites in Arizona (USFS 2019). While the use of one of these brownfields sites would likely have avoided impacts to waters of the U.S., the agencies determined that none of the brownfields alternatives were

available, feasible, or reasonable alternatives for TSF locations and those sites were therefore dismissed from detailed analysis. After dismissal of the brownfield alternatives, 15 initial alternative TSF locations to that location proposed in the GPO were screened and assessed using criteria developed from the public and agency scoping processes conducted by the USFS, as well as input from cooperating agencies and Resolution Copper (USFS 2019).

Numerous aspects of TSF design and construction such as embankment type (e.g., upstream, centerline, modified centerline, and downstream embankments), foundation treatment and lining options, management of PAG tailings, and deposition methods (e.g., conventional thickened, high-density thickened, and filtered, or 'dry-stack') were assessed for use at these locations as described in the DEIS (USFS 2019). Five TSF alternatives were ultimately considered for detailed analysis in the DEIS (USFS 2019) and practicability analysis (WestLand 2019), and included a mix of locations, embankment types, and tailings deposition and placement technologies. A number of onsite mitigation measures (referred to as "applicant committed environmental protection measures") were incorporated into the TSF designs to address impacts to the aquatic environment, including waters of the U.S., and water quality and quantity functions. Although the area beneath the footprint of the TSF and its appurtenant features will no longer contribute runoff from precipitation to downstream drainage reaches, the TSF design minimizes impacts to downstream waters of the U.S. by diverting upstream stormwater flows around the facility. Similarly, the stormwater controls, run-on diversions, and engineering controls have been designed to maintain downstream stormwater flows while minimizing the risk of contaminant discharge to downstream surface water features to the maximum extent practicable.

Given that the footprints of the practicable TSF alternatives contain ephemeral drainage channels and will be operated as part of an active copper mine, little opportunity exists for the development of onsite mitigation for unavoidable impacts to waters of the U.S. Aquatic habitat functions that will be lost through development of the TSF are anticipated to be mitigated offsite.

4. PROJECT IMPACTS TO WOTUS

As proposed, only the development of the TSF and associated infrastructure (including pipelines) may require a discharge of dredged or fill material into waters of the U.S. Discharge of fill for the development of these features, particularly the TSF, consists mostly of the levelling of existing topography through cut and fill of the natural ground surface. Materials to be discharged would consist of native soil and rock taken from the footprint of the constructed features during the grading process.

The aquatic resources at all of the TSF alternatives carried forward for evaluation in the DEIS (USFS 2019) and the practicability analysis (WestLand 2019) are comprised almost entirely of ephemeral washes. The ephemeral wash systems flow only in direct response to precipitation events and typically support some level of xeroriparian habitat. Two alternatives also include groundwater dependent ecosystems (e.g., seeps, springs) that support habitat more indicative of the hydric conditions. In general,

these features exist in a largely unaltered state with primary land use within these footprints consisting of ranching or light recreational use.

The South Pacific Division of the Corps has developed the *Standard Operating Procedure for the Determination of Mitigation Ratios* (Corps 2015) for determining compensatory mitigation requirements for the processing of CWA Section 404 permits. The substantive component of this procedure is completion of the Mitigation Ratio-Setting Checklist (MRSC). The completed MRSC is intended to provide a ratio determining the amount of acreage necessary as compensatory mitigation to offset the acreage of authorized impacts, in compliance with the 2008 Mitigation Rule. Completion of the MRSC comprises a 10-step process that includes a functional analysis of impacted waters of the U.S. and proposed mitigation parcels, establishes baseline mitigation ratios, and authorizes adjustment of those ratios based on specified criteria.

Step 1 within the MRSC is the identification and classification of the aquatic resources present at and functions provided by the impact site and the proposed mitigation site. If a TSF alternative that has impacts to jurisdictional waters of the U.S. is identified by the Corps as the LEDPA, the aquatic resources at the impact site and mitigation site will be classified by their hydrologic, chemical, and biotic function. Step 2 of the MRSC is a qualitative assessment of the functions of the aquatic resources impacted and an assessment of the functional gain from the proposed mitigation actions. The assessed functions will be consistent with those hydrologic, chemical, and biotic functions identified in the South Pacific Division's *Standard Operating Procedure for the Determination of Mitigation Ratios* (Corps 2015). An example of 11 functions typically utilized for this purpose are listed in **Table 1**.

Table 1. Functions Evaluated for TSF Impacted Drainages

Evaluated Functions
HYDROLOGIC FUNCTIONS
Hydrologic Connectivity
Subsurface Flow and Groundwater Recharge
Energy Dissipation
Sediment Transport/Regulation
CHEMICAL FUNCTIONS
Elements, Compounds, and Particulate Cycling
Organic Carbon Export/Sequestration
BIOTIC FUNCTIONS
Aquatic Invertebrate Fauna
Presence of Fish and Fish Habitat Structure
Riparian/Wetland Vegetation Structure
Age Class Distribution of Wooded Riparian or Wetland Vegetation
Native/Non-native Plant Species

Evaluation of these eleven functions will be based on available data, published literature, aerial photography, general field observations, and field data collected from both the impact and proposed mitigation sites. It is anticipated that this effort will also include use of the *California Rapid Assessment*

Method (CRAM) *Episodic Riverine Field Book, version 2.0* (CWMW 2018), which was specifically developed to assess the functionality of ephemeral drainages based on relationships between condition and function. The functions of each identified drainage class will be scored qualitatively. The assessment of ephemeral drainages impacted will compare on-site aquatic features to normally functioning reference washes of the same class and similar flow regime. These functions will then be compared to those aquatic functions provided by the proposed mitigation activities to assess aquatic functions and values lost if the Project is permitted compared to aquatic functions and values gained through mitigation. Given the nature of the proposed mitigation sites, it is likely that this will require a functional comparison of services provided by ephemeral systems to services provided by perennial and intermittent systems (e.g., the Gila River). The assessment is not intended to make a value judgement between ephemeral and perennial systems; rather, the assessment fulfills the purposes of the MRSC to provide a comparative assessment of the functionality of the systems at the impact and mitigation sites and to develop a mitigation ratio that will ensure there is no net loss of aquatic functions and values. It is likely that this comparison will remove from the list of assessed functions factors such as 'Presence of Fish Habitat and Structure' not provided by ephemeral systems that would more heavily weight perennial or intermittent regimes.

To compensate for these unavoidable impacts and functional losses, five offsite mitigation opportunities have been identified that provide the potential for functional gains through implementation of active management, enhancement, restoration, and preservation activities.

5. MITIGATION OPPORTUNITIES

The 2008 Mitigation Rule identifies general classes of compensatory mitigation and identifies clear preferences among these classes, specifically noting that mitigation banks[1] and then in-lieu fee (ILF) mitigation are preferred over permittee-responsible onsite or offsite mitigation. As a general matter, in-kind mitigation is preferred over out-of-kind mitigation.

In accordance with the Corps's *Final 2015 Regional Compensatory Mitigation and Monitoring Guidelines* (2015), Resolution evaluated mitigation opportunities, based on the above hierarchy, within the Project watershed (Middle Gila Watershed [USGS HUC 15050100]) and adjacent watersheds. WestLand is not aware of any watershed planning efforts for the HUC-6 or HUC-8 watersheds within which the Project is located that identify specific restoration goals for aquatic resources. No onsite mitigation opportunities were identified.

Five offsite mitigation opportunities (**Figure 2**) have been identified as Potential Mitigation Opportunities (**Section 5.1**). The relative benefits of each mitigation opportunity are discussed based on WestLand's recent experience working within the framework of the 2008 Mitigation Rule on similar mining projects (WestLand 2017, 2018) and following Corps guidelines (Corps 2015). The mitigation opportunities include both permittee-responsible and ILF mitigation. Fulfillment of mitigation under

1 There are currently no mitigation banks established in Arizona.

each opportunity would provide regional conservation benefits, though not all of the proposed mitigation measures will create xeroriparian habitat similar to the habitat that will be lost or impacted by the Project. Some of the opportunities entail preservation, enhancement, and restoration of high-value mesoriparian and hydroriparian habitats, which are rarer within the regional landscape and have higher productivity and wildlife values (Lowery, Stingelin, and Hofer 2016).

5.1. Potential Mitigation Opportunities

5.1.1. GRIC MAR-5 Recharge Project

The Gila River Indian Community (GRIC, the Community) MAR-5 Recharge Project is, to-date, a 3-year pilot study to evaluate the effectiveness of recharging a portion of the GRIC allotment of CAP water into the Gila River, on the Community's lands (**Appendix A**). Over the 3-year pilot study, CAP water was discharged at a single turnout near the Olberg Road Bridge in GRIC District 3. Water discharge at the site initiated in August 2015, and vegetation monitoring was conducted at the site each year from 2015 through 2017, including baseline data collection in June 2015. The pre-discharge vegetation of the area was described as a sparse collection of upland woody shrubs with desert forbs and Bermudagrass (*Cynodon dactylon*), along with the nonnative, invasive tamarisk (*Tamarix* spp.). The 2017 data show a five-fold increase in total vegetation volume and a six-fold increase in total herbaceous cover, and at the end of the pilot study the site was populated with desirable riparian species including cattails (*Typha* spp.) and Goodding's willow (*Salix gooddingii*). Tamarisk density at the site also increased substantially, from 11 plants per hectare in June 2015 to 352 plants per hectare in 2017 (**Appendix A**).

The instream discharge created an approximately 123-acre wetted area at the GRIC MAR-5 site (**Figure 3**), and it is anticipated that continued discharges would allow for significant ecological lift as riparian habitat in this area continues to develop, though Corps guidance (2015) indicates that mitigation credited towards this lift may be negatively-impacted by the presence and density of tamarisk. The GRIC Department of Environmental Quality has recently conducted limited tamarisk removal and native plant reseeding at the GRIC MAR-5 site and has identified a large tamarisk thicket directly upstream that is likely a major seed source contributing to the tamarisk colonization and proliferation at the GRIC MAR-5 site. Tamarisk removal and native reseeding efforts at the upstream tamarisk seed source are described in the Olberg Road Restoration Site Project mitigation option (**Section 5.1.3**).

The Corps places a high value on restoration projects (33 CFR 332.3(a)(2)), and the GRIC MAR-5 recharge project represents a significant restoration effort on one of Arizona's largest river systems. The Corps prefers that mitigation take place within the same watershed as the impacted site (33 CFR 332.3(b)), and the GRIC MAR-5 site occurs within the same HUC 8 watershed, the Middle Gila, as the Project (**Figure 2**). Additionally, the Community has indicated that the GRIC MAR-5 recharge project would restore a cultural resource (surface flows in the Gila River), which has significant traditional value to the Community.

5.1.2. Lower San Pedro River Wildlife Area In-lieu Fee Project

The ILF mitigation programs allow impacts to surface water features to be mitigated through funds paid to a governmental or non-profit natural resources management entity as a means to satisfy compensatory mitigation requirements (Corps & EPA 2008). These programs are a form of compensatory mitigation that can aid in larger restoration efforts, making ILF projects (along with mitigation banks) the Corps's preferred method of compensatory mitigation (Corps 2015).

The Arizona Game and Fish Department (AGFD) has developed an ILF mitigation project, the Lower San Pedro River Wildlife Area (LSPRWA) along the San Pedro River near Winkelman, Arizona. Although the LSPRWA ILF project is located within the Lower San Pedro (HUC 8) watershed adjacent to the Project area's watershed (**Figure 2**), the ILF project itself is located near the watershed boundary and has been used as mitigation for other projects located in the Middle Gila River HUC 8 watershed (WestLand 2018). The LSPRWA ILF project consists of converting over 100-acres of agricultural fields to native pasture grasses to reduce groundwater consumption and help restore base flows and riparian habitat (BFWS 2019). Additionally, the restoration project will involve substantial exotic species removal and subsequent plantings to establish native woody vegetation within the 2,116 acre site (Lowery, Stingelin, and Hofer 2016).

The AGFD has indicated in a letter to Resolution Copper (**Appendix B**) that all advanced credits available for purchase through the LSPRWA ILF project have been sold or obligated for sale. However, AGFD will expand the LSPRWA ILF project to make an additional 650 credits available for purchase through five future phases of development. Resolution may purchase as many LSPRWA ILF credits as necessary to meet the mitigation requirements needed to offset impacts resulting from the project. Given the lengthy mine construction period, tailings would not need to be placed for at least a decade. As such, additional credits are anticipated to be available well before impacts from TSF deposition.

The LSPRWA ILF project has previously been used as mitigation by Asarco in support of the proposed Ripsey Wash TSF project (Ripsey) (WestLand 2018). Ripsey is similar to the Project in that for both projects, all proposed impacted drainages are ephemeral. Mitigation ratios established using the LSPRWA ILF to offset impacts from Ripsey were set at 1:1 for both newly-established wetland habitat and restored riparian habitat (WestLand 2018). Due to the similar nature and functional value of the proposed impacted drainages between Ripsey and the Project, WestLand assumes that a mitigation ratio of 1:1 or similar would be used for the Project.

5.1.3. Olberg Road Restoration Site Project

The proposed 23-acre Olberg Road Restoration Site (ORRS) is located along the south bank of the Gila River just east of the Olberg Bridge in GRIC District 3, immediately upstream of the GRIC MAR-5 site (**Figure 3**). The conceptual mitigation strategy for the ORRS project consists of exotic tree species (principally tamarisk) removal and control, combined with native plant species reseeding. Nonnative, invasive tamarisk has shown substantial increase in cover at the GRIC MAR-5 site during

the 3-year pilot study (**Appendix A**), prompting identification of the 23-acre ORRS as a major tamarisk seed source for the GRIC MAR-5 site. Exotic tree species removal and control combined with seeding of native plant species at the ORRS site would allow for the establishment and maintenance of a riparian habitat dominated by native tree species, and eliminate a large, local source of exotic tree species seed from that section of the Gila River.

The ORRS project is not expected to generate the same ecological lift and mitigation credit value as the GRIC MAR-5 site, as it provides fewer ecological benefits relative to restoring surface flows and high-value riparian vegetation. The mitigation actions associated with tamarisk removal and reseeding would be considered as restoration.

5.1.4. Queen Creek Project

Conceptual mitigation elements for the Queen Creek project consists of actions to improve the ecological condition of a stretch of Queen Creek near Superior, Arizona (**Figure 2**). The actions include the removal of tamarisk to allow riparian vegetation to return to its historic composition and structure and promote more natural stream functions. Additionally, a conservation easement would be established, covering approximately 150 acres along 1.8 miles of Queen Creek to restrict future development of the site and provide protected riparian and wildlife habitat. The 150-acre Queen Creek project area includes lands owned by Resolution and BHP Mineral Resources, Inc. (BHP).The Corps would likely categorize the Queen Creek project as an enhancement (lift of one or a few selected functions) project. However, important to note is that the Queen Creek project would be accessible and highly-visible from Superior (**Figure 2**), allowing a local community affected by the Project to be a major beneficiary of the mitigation.

5.1.5. Arlington Wildlife Area In-lieu Fee Project

The Arlington Wildlife Area (AWA), another AGFD ILF mitigation project, is a 1,500-acre wetland and riparian habitat restoration project along the west bank of the Gila River in Maricopa County, Arizona. The AWA is located within the Lower Gila (HUC 8) watershed, adjacent to the Project area's Middle Gila watershed (**Figure 2**). The AWA consists of agricultural lands, constructed wetlands, and riparian areas dominated by tamarisk and mixed native and non-native vegetation (AGFD 2019). Restoration actions at the AWA consist of streambank shaping, erosion control, and native revegetation. As an ILF project, the Corps places high value on this opportunity due to its potential to have a substantial impact on broader restoration efforts.

6. LONG-TERM SITE PROTECTION INSTRUMENTS

All of the permittee-sponsored mitigation opportunities (GRIC MAR-5 Recharge Project, ORRS Project, and the Queen Creek project) to the extent necessary will have a suitable site-protection instrument recorded in their respective counties or tribal government to provide long-term protection of the conservation objectives outlined here and to comply with the 2008 Mitigation Rule. The details

of the site-protection instruments to be recorded at these mitigation sites have not been finalized at this time, though incompatible uses will be prohibited. Some low-impact public uses such as hiking and bird watching may be allowed in certain areas. The permittee would provide funds for the long-term management of the sites pursuant to the respective site-protection instrument.

7. REFERENCES

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FIGURES

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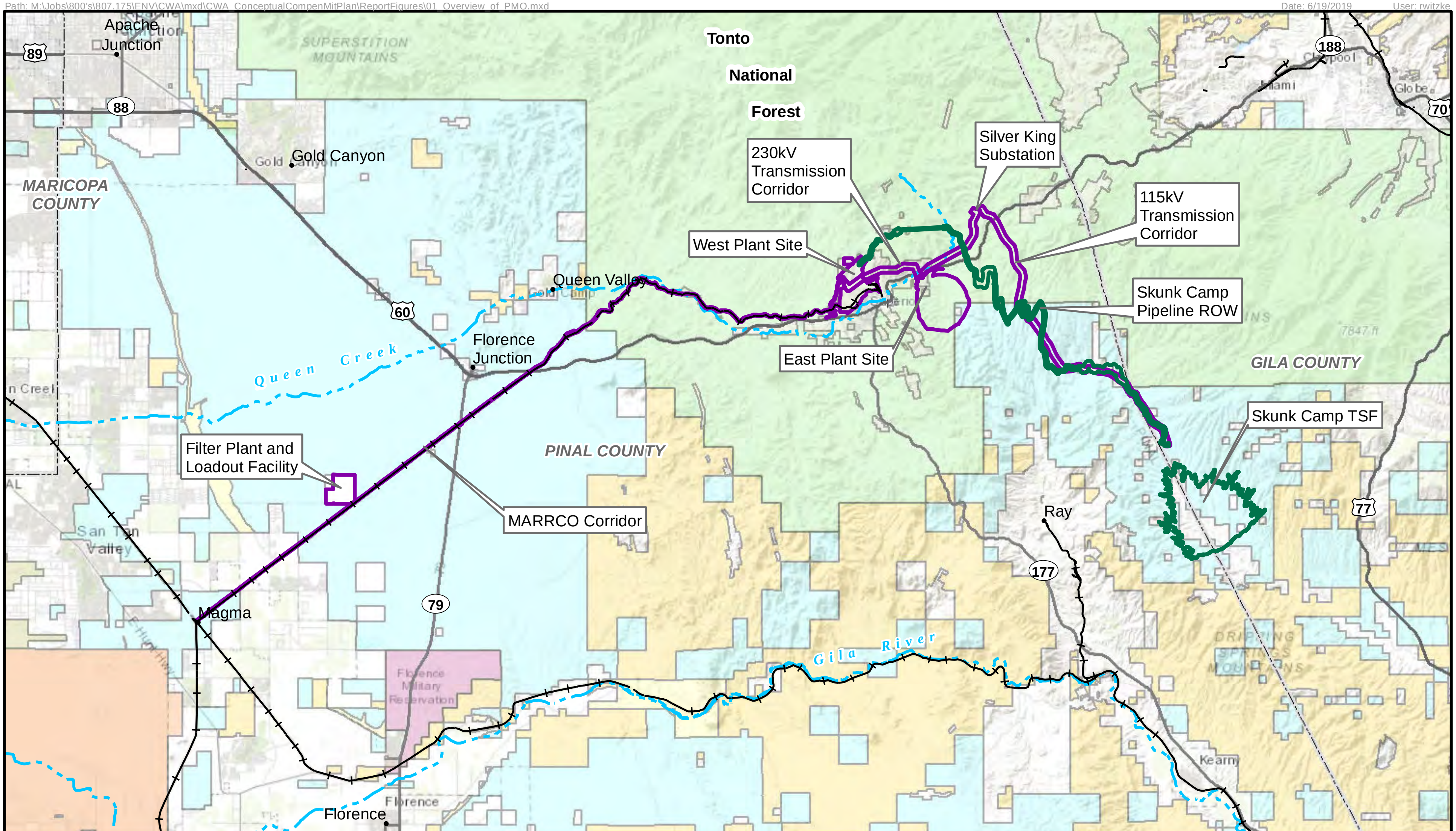

Pinal and Gila Counties, Arizona,
Data Source: BLM 2018, WRI Modified 2019,
ALRIS, SWCA, and USFS
Image Source: ArcGIS Online, World Topo Map

Legend

- Proposed Action
- GPO Mine Elements

Surface Management (BLM)

- County
- Indian Lands
- Local or State Parks
- Other
- State Trust Land
- Bureau of Land Management (BLM)
- Military
- Bureau of Reclamation
- Private Land
- US Forest Service (USFS)

N

0 2.5 5 Miles

0 4 8 Kilometers

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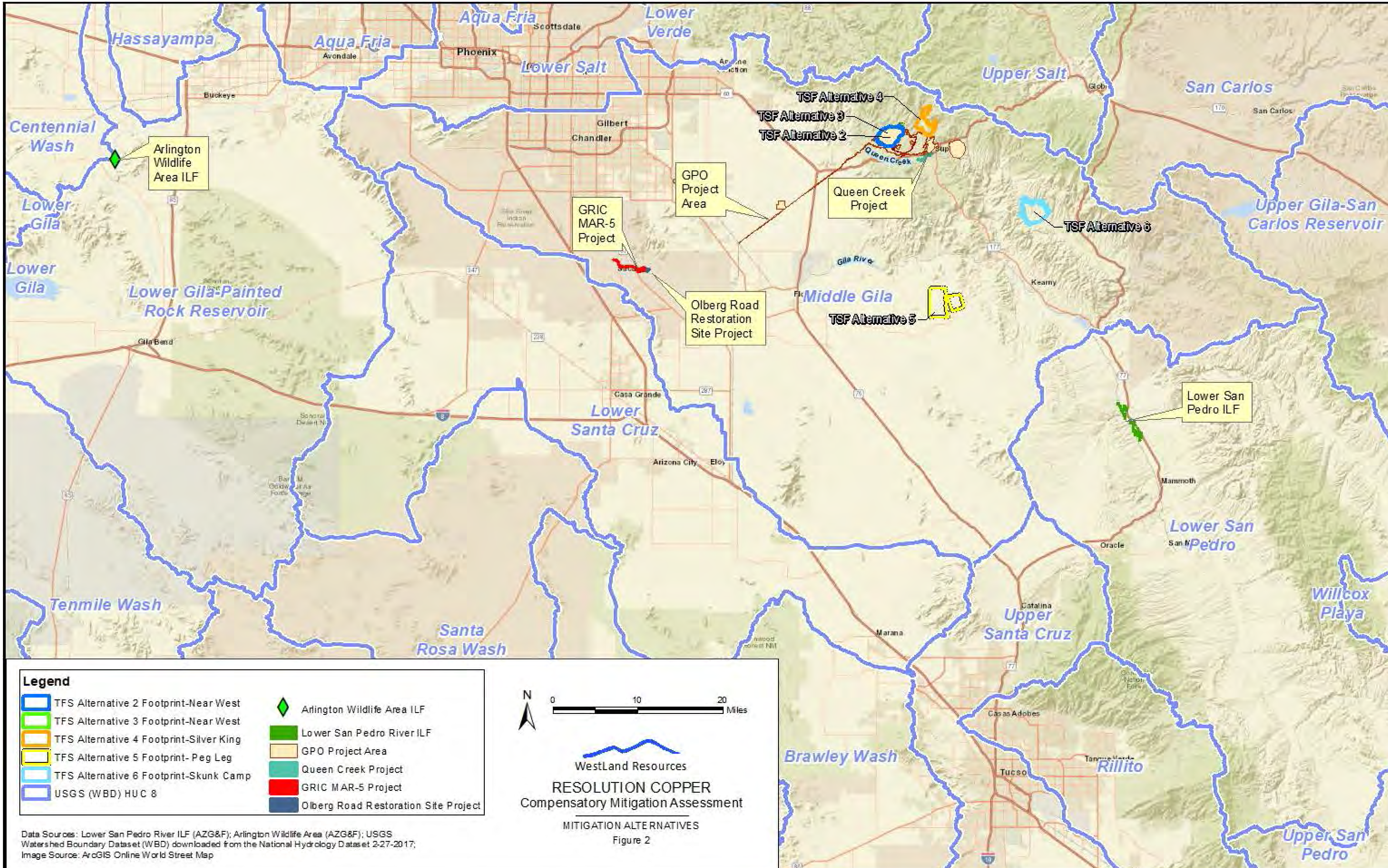
RESOLUTION COPPER
CWA Conceptual Compensatory Mitigation Plan

OVERVIEW OF
PROPOSED MINING OPERATION

Figure 1


Hassayampa
Aqua Fria
Aqua Fria
Lower Verde
Lower Salt
Upper Salt
San Carlos
Centennial Wash
Arlington Wildlife Area ILF
TSF Alternative 4
TSF Alternative 3
TSF Alternative 2
GPO Project Area
Queen Creek Project
GRIC MAR-5 Project
Olberg Road Restoration Site Project
TSF Alternative 6
Upper Gila-San Carlos Reservoir
Lower Gila
Lower Gila
Lower Gila-Painted Rock Reservoir
Middle Gila
TSF Alternative 5
Lower San Pedro ILF
Lower Santa Cruz
Lower San Pedro
Tenmile Wash
Santa Rosa Wash
Upper Santa Cruz
Willcox Playa
Brawley Wash
Rillito
Upper San Pedro
Legend
TFS Alternative 2 Footprint-Near West
TFS Alternative 3 Footprint-Near West
TFS Alternative 4 Footprint-Silver King
TFS Alternative 5 Footprint- Peg Leg
TFS Alternative 6 Footprint-Skunk Camp
USGS (WBD) HUC 8
Arlington Wildlife Area ILF
Lower San Pedro River ILF
GPO Project Area
Queen Creek Project
GRIC MAR-5 Project
Olberg Road Restoration Site Project
N
0 10 20 Miles
WestLand Resources
RESOLUTION COPPER
Compensatory Mitigation Assessment
MITIGATION ALTERNATIVES
Figure 2
Data Sources: Lower San Pedro River ILF (AZG&F); Arlington Wildlife Area (AZG&F); USGS Watershed Boundary Dataset (WBD) downloaded from the National Hydrology Dataset 2-27-2017;
Image Source: ArcGIS Online World Street Map

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T4S, R6E, Portions of Sections 8 - 14,
Pinal County, Arizona.
Image Source: Pleiades Satellite Imagery 10/28/2017

0 800 1,600 Feet
0 250 500 Meters
N

Legend

- Olberg Road Restoration Site Project
- MAR-5 Wetted Area

RESOLUTION COPPER
CWA Conceptual Compensatory Mitigation Plan

GRIC MAR-5 PROJECT
Figure 3

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APPENDIX A

Gila River Indian Community MAR-5 2017 Vegetation Monitoring Report

GILA RIVER INDIAN COMMUNITY MAR-5
2017 VEGETATION MONITORING REPORT
Resolution Copper

Prepared for:

RESOLUTION COPPER

102 Magma Heights – Superior, Arizona 85173
Project Number: 807.131 03 02
May 2019

WestLand Resources

WestLand Resources, Inc. • 4001 E. Paradise Falls Drive • Tucson, Arizona 85712 • 520•206•9585

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(follow text)

APPENDICES

1. INTRODUCTION AND BACKGROUND

WestLand Resources, Inc. (WestLand), was retained by Resolution to conduct vegetation monitoring of restoration efforts in partnership with the Gila River Indian Community (GRIC) through the discharge of Central Arizona Project (CAP) water to the Gila River as part of a Managed Aquifer Recharge (MAR) and riparian restoration pilot program.. Instream discharge of the GRIC CAP water allocation into the Gila River is currently conducted at a single turnout near the Olberg Road Bridge, referred to as MAR-5. The GRIC MAR-5 recharge study site is situated along the southern side of the Gila River, approximately 1 mile north of the town of Sacaton in Township 4 South, Range 30 East, Sections 9 through 11, 13, and 14 (the Project Area; **Figure 1**).

A 3-year pilot study to evaluate the effectiveness of the discharge at MAR-5 was initiated in 2015. Baseline vegetation data was collected in June 2015 before the initial discharge of water in July 2015. Additional vegetation data was collected in November and December 2015, November and December 2016, and November 2017.

This report presents the baseline vegetation data collected in June 2015 and provides a comparative analysis to the vegetation data collected in November-December 2015, November-December 2016, and November 2017 after instream discharge commenced at MAR-5. The report is presented in five sections: **Section 1**: Introduction, **Section 2**: Methods, **Section 3**: Results, **Section 4**: Discussion, and **Section 5**: References.

2. METHODS

Although the Corps has no approved wetlands functional assessment model for determining ecological restoration benefits in Arizona, WestLand used the Planning-based Wetland Functional Assessment Model developed by the Corps (Webb and Burks-Copes 2009) to establish an index of hydrological function of the MAR-5 recharge pilot study site, called its Functional Capacity Index (FCI). The FCI is a value ranging from 0 to 1 which reflects the quality of the evaluated wetland area relative to a hypothetical properly-functioning wetland. An index of "1" indicates that the wetland functions at a level equivalent to a wetland under reference standard conditions (Webb and Burks-Copes 2009), and an index at or above 0.50 indicates that the wetland has a moderate to high functional capacity (Burks-Copes and Webb 2003). The FCI is calculated by evaluating ten functions (e.g., channel dynamics, nutrient cycling, habitat structure), which in turn are calculated by formulas involving a total of 27 variables. Most of the variables are measured at the field sites; a few are evaluated using GIS. The Model converts measured variable values into a Variable Subindex (VSI) score for each variable, which ranges from 0 to 1. The VSI values comprise the variables within the formulas that calculate an FCI for each of the ten wetland functions. The FCI values of the 10 functions are averaged to produce an overall FCI for each sampled site. An overall average among all sites provides a single FCI for the entire study area. The FCI of the site is multiplied by the acreage of

the represented area to calculate Functional Capacity Units (FCU). The value of the FCU reflects the quality and quantity of the wetland area, and can be compared among sites and over time for purposes of monitoring and mitigation.

2.1. Field Methods

The Model recognizes five types of wetlands (termed Partial Wetland Assessment Areas [PWAA]) in southern Arizona. All the study transects were in the Scrub-Shrubland PWAA, characterized by the presence of shrubs (defined as woody vegetation less than 3 inches in diameter at breast height), but lacking trees (>3 inches diameter at breast height). Also in the floodplain of the Gila River but outside of the channel wetted by discharge from MAR-5 are extensive areas of the Dry Riverbottom PWAA, characterized by a lack of woody vegetation (Webb and Burks-Copes 2009).

Prior to fieldwork, 38 study transects were selected by inspection of aerial imagery within the area predicted to be wetted from the discharges. Study transects were located perpendicular to the channel at intervals of approximately 200 meters (m). The lengths of the proposed transects varied in accordance with the width of the predicted wetted area (**Figure 2**). Throughout the four data collection periods, some transects were shortened, others were omitted, to better represent the wetted discharge channel and to omit non-wetted areas. Data was collected from 27 transects in June 2015, from 24 transects in November-December 2015, from 18 transects in November-December 2016, and from 24 transects in November 2017 (**Figure 3**). For transects that were shortened in November-December 2015 to include only wetted areas, the June data reported in **Section 3** was adjusted to correspond to the shortened transects, by deleting data points that were recorded in omitted sections of the transects.

At each transect, the following data were collected:

- Total Vegetation Volume (TVV)
- Percent Cover
- Belt Density of Woody Species
- Hydrological Variables
- Photographs

2.1.1. Total Vegetation Volume

The total vegetation volume (TVV) index is used to characterize community structure and composition of the vegetation and to provide an indication of overall productivity. This technique samples a series of one-decimeter (dm)-high by one-dm-radius cylinders (3.14 dm^3) from the ground surface through the top of the vegetation canopy at regular intervals along established transects. At each of the sample points per transect, a straight rod was held vertically; any live woody vegetation that occurred within a 10-centimeter (cm) radius cylinder centered on the vertical rod was recorded

by species as "hits". Data was separated into 1-m vertical increments (ground-1 m, 1-2 m, 2-3 m, 3-4 m, 4-5 m, 5-6 m, 6-7 m, 7-8 m, and >8 m). Each vertical meter increment could have a maximum of 10 hits, corresponding to the number of 10-dm high x 10-cm radius cylinders occupied by live vegetation, within each vertical 1-m increment. For vegetation that occurred higher than 8 m, one hit was scored per species in the >8-m category.

The calculation procedure for computing vegetation volume data is provided below:

h_i = total number of hits (dm layers containing vegetation) at the i^{th} sample point

n = the total number of sample points within the transect

$\sum_{i=1}^{n} h_i$ = the sum of all hits within the transect

The sum of the hits can be used to calculate the volume of vegetation per dm^2 area for the transect:

$$\text{Vegetation volume per area (in decimeters)} = \frac{\sum_{i=1}^{n} h_i * 3.14dm^3}{n * 3.14dm^2}$$

The vegetation volume as cubic meters of vegetation per square meter, then, is calculated as:

$$\text{Vegetation volume per area (in meters)} = \frac{\sum_{i=1}^{n} h_i * 3.14dm^3}{n * 3.14dm^2} * \frac{1m^3}{1{,}000dm^3} * \frac{100dm^2}{1m^2}$$

This total vegetation volume per area can then be simplified and stated as an index value, TVV:

$$\text{TVV} = \frac{\sum_{i=1}^{n} h_i}{10n}$$

2.1.2. Percent Cover

Percent cover is defined as the proportion of the ground area that is covered by plant canopy, algae, water, or dead plant matter; the balance is bare ground. Plant canopy cover can be visualized as the outline projected to the ground resulting from draping a form-fitting sheet over the individual plant, i.e. ignoring small gaps in the canopy.

Percent cover was evaluated in June 2015, November-December 2016, and November 2017 with the line-intercept method, using the same transect lines established for TVV. Line-intercept essentially maps the transect in terms of the plants, litter, or bare ground that lie in a vertical plane defined by the transect. The observer begins at the 0-m mark on the transect tape and records the start and stop measures for each feature encountered along the line. For example, bare ground from 0 m to 13.75 m, mesquite

canopy from 13.75 m to 20.30 m, etc., until the end of the transect is reached. Percent cover is calculated for each plant species and for litter and bare ground by summing the lengths for each feature and dividing by the total transect length. Adjustment of June data to the shortened November-December 2015 transects was accomplished by deleting any data points that occurred in portions of the transect that were later omitted. For example, Transect 3 was shortened from 250 m to 200 m; therefore, the June cover data that occurred in the last 50 m of the transect was deleted for comparison to later data.

In November-December 2015, plant cover was evaluated with the line-point method. Percent cover of a plant species or ground cover type is calculated as the percent of sample points in which the species occurred. The transect was sampled by identifying the plant species and ground cover that occurred at a series of points located at regular intervals. At each sample point, a vertical line was projected. The plant species and any dead plant matter that the vertical line intercepted was recorded. If more than one live plant species was intercepted, both species were recorded, as well as any dead plant matter. The cover of algae, algal remnants, or standing water was recorded. If there was neither live plant nor dead plant matter at the point, bare ground was recorded. Dead plant matter was recorded in one of these categories:

- LITTER (non-woody)
- FWD (Fine woody debris) ≤ 2.5 inches diameter
- CWD (Coarse woody debris) ≥ 2.5 inches diameter

2.1.3. Belt Density

Density is defined as the number of individual plants or plants of a given species per unit of area. Plant density monitoring occurred in June 2015 before the initiation of instream discharges to establish the baseline, and in November-December 2015, November-December 2016, and November 2017.

Plant density data was collected in 5-m-wide belt transects, which varied in length depending on the width of the channel (**Figure 3**). The belt transects were divided into 10-m by 5-m segments, and the number of individual perennial plants of each woody species that were more than 0.5 m in height was recorded within each segment. The ground rule for distinguishing conspecific individuals was a separation of at least 1 m between rooted stems. The division of the belt transects into segments enabled inter-year comparisons for transects that were shortened, by omitting the June 2015 data for any 10 m segments not later sampled. To document recruitment and establishment of seedlings, in November-December 2016 and November 2017, the woody plants were counted in these height classes: <20 cm, 21-50 cm, 51-100 cm, 101-200 cm and > 200 cm.

2.1.4. Photopoints

Photographs were taken from the endpoints of each of the transects, with views along the transects towards the other endpoint (**Appendix A**). Prints of the earlier photographs were taken into the field to ensure that the photos were matched (**Appendix A**).

2.1.5. Hydrological Variables

The following variables were evaluated in the field in November-December 2015, November-December 2017, and November 2017, using scores presented in the Model document (Webb and Burks-Copes 2009). Use of the Model was not implemented in time to collect data prior to discharge, thus there are no pre-discharge scores for these variables.

- DECAY: Presence of coarse woody debris in various stages of decomposition.
- FREQ: Frequency of inundation. This variable is intended to reflect the frequency of flood events necessary to inundate the site with perennial flow scored highest and 100-year flood return interval scored lowest.
- PORE: Soil pore space available for storing sub-surface water; depends on soil permeability. This variable was scored from 1 to 5, with a score of 1 indicating no restrictive layer and a score of 5 indicating a non-porous substrate.
- Q: This variable scores alterations of hydroregime by human activities, with no alterations scored highest and alterations with substantial changes to channel morphology scored lowest.
- SED: This variable scores the extent of sediment delivery to the wetland from human activity, with no human activity affecting sediment delivery scored highest, and site entirely filled with sediment from human sources scored lowest.
- SPECRICH: Species richness. A complete species list was made at each site on the same stream terrace and within 50 m upstream and downstream of each transect.
- SUBIN: Subsurface flow. This variable scores subsurface flow into the wetland either from adjacent lands or upstream sources, with subsurface flow evident scored highest and subsurface flow not evident scored lowest. Evidence of subsurface flow, in the absence of surface water, was marsh vegetation (cattails, bulrushes, reeds).
- SURFIN: Surface inflow from sheetflow. This variable was evaluated relative to an imaginary well-functioning reference area of the same PWAA in a similar hydrogeomorphic position. The variable scores surface inflow present and similar to pristine area highest, and no surface inflow with channelization scored lowest.
- TOPO: Macro- and microtopographic relief. Roughness and relief increase wetland function, by slowing and retaining water flow across the surface. Macrotopography refers to large-scale features such as bars and swales. Microtopography refers to small-scale features such as

pit-and-mound and hummock-and-hollow. This variable was scored from 1 to 5, with a score of 1 indicating complex macro and micro topographic relief and a score of 5 indicating steep banks and channelization, variable not recoverable.

- VEGSTRATA: Number of vegetation layers present. This variable has 14 categories from broad leaved tree to biotic soil crust. The more categories present, the higher the score.
- WIS: Wetland indicator score. This variable was evaluated after data entry, and was based on the plant species present. The Corps publishes an online list of species for the state of Arizona (Lichvar et al. 2016), with scores reflecting the degree to which a moist wetland habitat is necessary for the species. The lowest score (i.e. most indicative of wetland conditions) among the species present at each transect was used for the variable WIS.

  Scores are:

  1. Obligate
  2. Facultative wetland
  3. Facultative upland
  4. Upland

2.2. GIS Methods

The following variables were evaluated by inspection of Google Earth imagery:

- BUFFWIDTH (distance in meters to nearest human disturbance)
- CONTIG (cover of contiguous vegetation between wetlands and uplands)
- FPA (flood prone area)
- LANDBUFF (calculated from LANDUSE and BUFFWIDTH)
- LANDUSE (type of adjacent land use)
- TRIB (presence of connected tributaries)

2.3. Data Entry and Analysis

The field data was entered into an Excel™ workbook, and the Variable Subindex Score (VSI, a number between 0 and 1) for each variable was calculated. The VSI values populated the formulas that calculated the FCI values for the ten wetland functions:

- CHANNELDYN: maintenance of characteristic channel dynamics
- WATSTORENR: dynamic surface water storage/energy dissipation
- WATSTORLNG: long-term surface water storage
- WATSTORSUB: dynamic subsurface water storage
- NUTRIENT: nutrient cycling

- ELEMENTS: detention of imported elements and compounds
- DETPARTICL: detention of particles
- PLANTS: maintain characteristic plant communities
- HABSTRUCT: maintain spatial structure of habitat
- INTERSPERS: maintain interspersion and connectivity

More detailed descriptions of these functions are included in the Corps report (Webb and Burks-Copes 2009) and provided in **Appendix B**.

The Model requires a breakdown of plant canopy cover into herbaceous, shrub, and tree species, but only defines trees as greater than 3 inches in diameter at breast height (Webb and Burks-Copes 2009). Shrubs were classified as perennial woody plants with persistent single or multiple stems less than 3 inches in diameter at breast height, and herbaceous species as perennial or annual non-woody plants with single or multiple stems that do not persist.

A spreadsheet was created that lists every species found in all sites, with an indication for each species whether it is an herb, shrub, tree, invasive, and its WIS, if available. Species were counted as invasive and included in the variable INVAS if they appeared on the lists of:

1. Plant species listed as noxious weeds by the state of Arizona (Arizona Department of Agriculture 2005), and
2. Other non-native plant species considered invasive in Arizona (Northam et al. 2016).

While TVV data was collected in the field by recording each species' contribution separately in 1-m by 20-dm cylinders; the data required by the Model is a single number, so all hits on all species were summed for entry into the data spreadsheets.

3. RESULTS AND DISCUSSION

3.1. Total Vegetation Volume

Comparisons of TVV index values by transect for the four sample periods are presented in **Table 1**, showing baseline data from June 2015 and post-discharge data from November-December 2015, November-December 2016, and November 2017.

Table 1. Total Vegetation Volume Index Summarized by Transect

Transect Number	Total Vegetation Volume Index, m^3/m^2			
	June 2015	November - December 2015	November - December 2016	November 2017
1	0	*	*	0.27
2	0.025	0.071	0.23	0.035
3	0.016	0	0.18	0.01
4	0.025	0.100	0.65	0.09
5	0.005	0.020	*	0.215
6	0.02	0.013	*	0.01
7	0.05	0.165	*	0.15
8	0.01	0.035	*	0.005
9	0.012	0.150	*	0.225
12	0.012	0	*	0.015
13	0.014	0.004	0.04	0.01
14	0.040	0.004	0.11	0
15	0.024	0	0.23	0.035
17	0.020	0	0.03	0.025
19	0.004	0	0.08	0.12
22	0.020	0	0.07	0.03
24	0.032	0	0.05	0.085
25	0.008	0.010	0.01	*
27	0.024	*	0.26	0.29
28	0.016	0	0.15	0.16
31	0.004	0	0.24	0.19
33	0.020	0.020	0.17	0.13
35	0	0	0	0.01
36	0.020	0	0.05	0
37	0.010	0.015	0.22	0.025
Average	0.017	0.0264	0.154	0.089

* Denotes transects that were not sampled during data collection.

The TVV values by transect of the most common woody species for each sampling period are presented in **Table 2**. All the woody species increased in volume over the study period; the greatest increase was in saltcedar (*Tamarix chinensis*).

Table 2. Total Vegetation Volume by Transect of Most Common Woody Species, June 2015, November-December 2015, November-December 2016, and November 2017

Transect	1	2	3	4	5	6	7	8	9	12	13	14	15	17	19	22	24	25	27	28	31	33	35	36	37
June 2015																									
Atriplex canescens	0	0.015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Baccharis sarothroides	0	0.01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Isocoma pluriflora	0	0	0.008	0.005	0	0	0	0	0	0	0.06	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Prosopis velutina	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.01	0	0	0
Tamarix chinensis	0	0	0.008	0.005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.005	0
November-December 2015																									
Atriplex canescens	0	0.009	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Baccharis sarothroides	0	0.011	0	0.070	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Isocoma pluriflora	0	0.011	0	0	0	0	0	0	0	0	0	0.004	0	0	0	0	0	0	0	0	0	0	0	0	0
Prosopis velutina	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.020	0	0	0.015
Tamarix chinensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
November-December 2016																									
Atriplex canescens	0	0.035	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Baccharis sarothroides	0	0.005	0	0.03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Isocoma pluriflora	0	0.065	0.065	0.125	0	0	0	0	0	0	0.015	0	0	0	0	0	0.015	0	0	0.065	0	0	0	0	0
Prosopis velutina	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.065	0	0	0.1
Tamarix chinensis	0	0.01	0.025	0.17	0	0	0	0	0	0	0	0	0.115	0.015	0.04	0.035	0.01	0.005	0.13	0.01	0.12	0.02	0	0.025	0.01
November 2017																									
Atriplex canescens	0.155	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Baccharis sarothroides	0.01	0	0	0.07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.03	0	0	0	0
Isocoma pluriflora	0	0.025	0.01	0	0.145	0.01	0.015	0.005	0	0	0	0	0.005	0	0	0	0.04	0	0	0.085	0	0	0	0	0
Prosopis velutina	0.04	0	0	0	0	0	0	0	0.21	0	0	0	0	0	0	0	0	0	0	0	0.03	0.095	0	0	0.005
Tamarix chinensis	0.065	0.01	0	0.02	0.07	0	0.105	0	0.015	0.015	0	0	0.03	0.025	0.12	0.03	0.045	0	0.27	0.075	0.13	0.035	0.01	0	0.02

3.2. Percent Cover

Comparisons of percent cover values of ground and plant cover categories averaged among transects during the four sample periods are presented in **Table 3**. There has been a decrease in bare ground, from 81.2 percent in June 2015 to 33.7 percent in November 2017. Herbaceous canopy cover has increased from 8.3 percent in June 2015 to 59.0 percent in November 2017, and shrub cover has increased from 3.3 percent to 10.5 percent.

Table 3. Percent Cover of All Categories of Ground Cover Averaged Across All Sampled Transects; June 2015, November-December 2015, November-December 2016, and November 2017

Ground Cover Categories	Average Percent Cover			
	June 2015	November - December 2015	November - December 2016	November 2017
Bare soil or rock	81.2	84.7	50.3	33.7
Litter	5.7	14.9	8.7	2.0
Herbaceous canopy	8.3	17.4	48.0	59.0
Shrub canopy	3.3	4.0	8.2	10.5

Comparisons of percent cover values of all plant species are presented in **Table 4**. The most notable changes, between June and November 2017 following the discharge of water in August 2015, were increases in herbaceous vegetation, mostly due to Bermudagrass (*Cynodon dactylon*), barnyard grass (*Echinochloa crus-galli),* and cattail (*Typha latifolia*). Cover of Bermudagrass averaged across all transects increased almost ten-fold, from 2.1 percent to 19.5 percent, and cover of barnyard grass increased from 0 to 17 percent (**Table 4**). The increase in cover of Bermudagrass and barnyard grass followed the discharge of water from MAR-5 and the summer rains. The increase in cattail cover, from 0 to 10 percent, can be directly attributed to the discharge from MAR-5, as it is an obligate wetland species (Lichvar et al. 2016) and is absent from the Gila River floodplain outside the discharge channel.

Table 4. Percent Cover of Live Vegetation; June 2015, November-December 2015, November-December 2016, and November 2017; Summarized by Species and Averaged Across All Sampled Transects

Species	Average Percent Cover			
	June 2015	November - December 2015	November - December 2016	November 2017
Ambrosia salsola	0	0.3	0.2	0.2
Amsinckia sp.	0	0.1	0	0
Atriplex canescens	0.3	0.2	0.2	0.4
Atriplex polycarpa	0.1	0.0	0.1	0
Atriplex rosea	4.3	0.0	11.0	0.9
Baccharis sarothroides	0.2	0.9	0.4	0.3
Bouteloua barbata	0	0.1	0.2	0
Brassica tournefortii	0	0.2	0	0
Camissonia sp.	0	0.3	0	0
Cynodon dactylon	2.1	11.4	13.4	19.5
Echinochloa crus-galli	0	0.3	5.2	16.9
Eclipta prostrata	0	0	0	4.2
Erodium cicutarium	0	0.3	0	0
Eriogonum sp.	0.1	0.0	2.5	0
Helianthus annuum	0	0	0	0.1
Heliotropium curassavicum	0	0	0.2	0
Isocoma pluriflora	1.1	1.2	2.8	2.3
Lactuca seriola	0	0	0	0.1
Leptochloa fulca	0	0	2.2	4.5
Pennisetum ciliaris	0	0.6	0.5	0.2
Prosopis velutina	0.6	1.0	0.3	1.6
Rumex sp.	0	0.0	1.7	0
Salsola tragus	1.6	1.3	7.0	1.5
Sonchus sp.	0	0.1	0	0
Sporobolus cryptandrus	0	0.1	0.3	0.1
Sphaeralcea sp.	0.1	0.1	0	0.1
Tamarix aphylla	0	0	0	0.1
Tamarix chinensis	1	0.3	4.2	5.6
Tidestromia lanuginosa	0	0.1	0	0.5
Tiquilia plicata	0.1	0.4	0.4	0.1
Typha latifolia	0	0	3.2	10.3
Unknown annual forb	0	0.2	0.1	0
Unknown annual grass	0	1.8	0	0

3.3. Belt Density

Comparisons of belt density of woody species by transect are presented in **Table 5**. To enable comparison across sampling periods, **Table 5** does not include shrubs less than 0.5 m high, as this data was only collected in November 2016 and 2017. Comparisons of belt density of woody species by species are presented in **Table 6**. Height class data for the seven most common woody species, averaged across all transects sampled in November 2017, is presented in **Table 7**.

Table 5. Total Woody Plant Density (Number of Plants >50 cm High Per Hectare) by Transect, June 2015, November-December 2015, November 2016, and November 2017

Transect	June 2015 *	Nov 2015	Nov 2016	Nov 2017
1	365	not sampled	not sampled	1050
2	1053	1093	3200	653
3	800	640	1490	750
4	914	900	1120	557
5	325	100	not sampled	1300
6	1286	1200	not sampled	457
7	320	1240	not sampled	1240
8	367	467	not sampled	267
9	100	250	not sampled	1200
10	100	0	not sampled	not sampled
11	0	0	not sampled	not sampled
12	171	114	not sampled	286
13	120	360	1160	40
14	0	280	not sampled	not sampled
15	0	0	6467	400
17	0	0	1333	267
19	0	0	1840	320
22	0	0	1750	700
24	0	100	7400	1000
25	0	200	1800	not sampled
27	0	0	6200	1600
28	100	0	1320	800
31	80	160	2560	640
33	0	0	800	700
35	400	0	400	533
36	100	100	1300	500
37	0	0	0	300

* June data was adjusted for any shortening of transects in November-December 2015 and November 2017.

Table 6. Woody Plant Density (Plants >50 cm Height Per Hectare) of Most Common Species Averaged Across All Sampled Transects, June 2015, November-December 2015, November-December 2016, and November 2017

Species	Belt Density (no. of plants per hectare)			
	June 2015 * (Baseline)	November - December 2015 (Post-discharge)	November - December 2016	November 2017
Ambrosia salsola	7	19	12	237
Atriplex canescens	18	20	20	95
Baccharis sarothroides	19	28	128	40
Isocoma pluriflora	158	207	524	149
Prosopis velutina	7	15	1	59
Salix gooddingii	0	0	87	12
Tamarix chinensis	11	6	1514	352
All woody species	244	300	2230	677

* June data was adjusted for any shortening of transects in November-December 2015 and November 2017.

From June 2015, before the initiation of MAR-5 discharge, to November-December 2015, all woody species increased in density, except for four-wing saltbush (*Atriplex canescens*) and saltcedar. In the period November 2015 to November 2016 desert broom (*Baccharis sarothroides*), jimmyweed (*Isocoma pluriflora*), Goodding's willow (*Salix gooddingii*), and saltcedar showed sharp increases in density, while mesquite showed a sharp decrease. The anomalously high-density data in 2016 may have been due to a mistaken sampling procedure: the rule of thumb for counting nearby plants as individuals was that each should be at least 1 m from a conspecific. This rule may not have been observed by the field crew in 2016, resulting in an overcount. The anomalous data for mesquite can be explained by the lack of data from transects that were not sampled in 2016 (transects 1, 5, 6, 7, 8, 9, and 12) in four of which mesquite had been present in 2015. Its large increase in 2017 was real, as it appeared for the first time in nine transects.

Table 7. Woody Plant Density (plants per hectare) by Height Class of Most Common Species Averaged across All Transects Sampled in November 2017

Species	Belt Density (no. of plants per hectare) by Height Class				
	< 20 cm	21-50 cm	51-100 cm	101-200 cm	>200 cm
Ambrosia salsola	0	2	18	13	1
Atriplex canescens	0	0	2	12	3
Baccharis sarothroides	0	3	14	19	3
Isocoma pluriflora	6	75	90	49	1
Prosopis velutina	9	24	10	5	11
Salix gooddingii	0	0	0	4	8
Tamarix chinensis	0	16	115	170	94

In the height class distribution shown in **Table 7**, a large proportion of plants of a given species in the smaller height classes (presumably younger individuals) indicates a growing population. Among these species, jimmyweed and mesquite show the most potential for population growth, with 37 percent and 57 percent respectively of their populations in the smaller two height classes. Goodding's willow, probably the most desirable tree species to become established in the wetted area (Webb and Burks-Copes 2009), has a low potential for increase given the small number of saplings present and the high cover of Bermuda grass in the wetter portions of the site as bare ground is required for willow recruitment (Stromberg 1993). Numerous willow saplings that had recently died were observed, probably a result of the fluctuations in ground water levels. Moist soils throughout the growing season are necessary for the establishment of willow recruits (Lite and Stromberg 2005, Stromberg 1993), and water stress effects are often most pronounced in the juveniles of a species (Lite and Stromberg 2005, Stromberg 1997).

3.4. INVASIVE SPECIES

Several species classified as non-native invasive plant to Arizona (Northam et al. 2016) occur in the GRIC MAR-5 study area, including buffelgrass (*Pennisetum ciliaris*), Sahara mustard (*Brassica tournefortii*), filaree (*Erodium cicutarium*), Bermudagrass, saltcedar, Athel tamarisk (*Tamarix aphylla*), Russian thistle, *Sonchus* sp., Mediterranean grass (*Schismus barbatus*), and barnyard grass. Bermudagrass, barnyard grass, and saltcedar have shown substantial increases in cover since the initiation of discharge in 2015 (**Table 5**).

3.5. HYDROLOGICAL VARIABLES

The field variables used in the Model were evaluated during fieldwork in November-December 2015, November-December 2016, and November 2017. The field and GIS variable values were converted to VSI scores and used to calculate the FCI scores for the three years. The overall averages of the FCI scores are presented in **Table 8**, as well as the FCU values (FCI multiplied by acreage). The slight increase in FCI score from 2015 to 2017 indicates that the site is approaching a moderate functional capacity (Burks-Copes and Webb 2003). Note that modifications to the MAR-5 discharge facility in 2017 resulted in an increased wetted area, which diverted water away from the established transects.

Table 8. Functional Capacity Index (FCI) Scores Averaged across All Sites and Functions, and FCU Values for the Entire Wetted Areas, Compared across All Sampling Periods

Category	November - December 2015	November - December 2016	November 2017
Overall Average FCI	0.44	0.61	0.47
Wetted acreage	53.9	53.9	123.4
FCU	23.7	32.9	58.0

The FCI scores for the hydrological functions evaluated at the transects in November-December 2015, November-December 2016, and November 2017 are provided in **Appendix C**. FCIs are scored from 0 to 1, with "1" considered a well-functioning wetland (riparian) site (Webb and Burks-Copes 2009). A comparison among years of FCI values for wetland functions averaged among all sample transects is provided in **Table 9**.

Table 9. Comparison Between Years of FCI Values Averaged across All Transects

Code	Name	2015	2016	2017
CHANNELDYN	Function 1: Maintenance of Characteristic Channel Dynamics	0.64	0.84	0.42
WATSTORENR	Function 2: Dynamic Surface Water Storage/Energy Dissipation	0.81	0.94	0.80
WATSTORLNG	Function 3: Long Term Surface Water Storage	0.51	0.92	0.66
WATSTORSUB	Function 4: Dynamic Subsurface Water Storage	0.50	0.50	0.50
NUTRIENT	Function 5: Nutrient Cycling	0.09	0.18	0.12
ELEMENTS	Function 6: Detention of Imported Elements and Compounds	0.32	0.51	0.41
DETPARTICL	Function 7: Detention of Particles	0.52	0.72	0.51
PLANTS	Function 8: Maintain Characteristic Plant Communities	0.17	0.50	0.47
HABSTRUCT	Function 9: Maintain Spatial Structure of Habitat	0.38	0.44	0.38
INTERSPERS	Function 10: Maintain Interspersion and Connectivity	0.40	0.51	0.40
	Average	**0.44**	**0.61**	**0.47**

The low FCI scores (less than 0.50) for most of the functions in **Table 9** indicate that, according to the Model, the GRIC MAR-5 site is presently not considered a well-functioning wetland (riparian) site. However, the site had just been recently tested with only 1 to 2 growing seasons, as such, it is expected that there would be significant potential for improvement. The water storage functions (Functions 2 - 4) will continue to improve with continued discharge from MAR-5. The CHANNELDYN, HABSTRUCT and INTERSPERS FCI scores will increase as more heterogenous habitats and contiguous areas of food and cover for wildlife develop with continued discharge of water into the channel. Likewise, the ELEMENT and NUTRIENT FCI scores will increase as plants colonize the wetted area and associated floodplain, and produce litter, fine and coarse woody debris, and increase the canopy and volume of vegetation.

The preponderance of invasive plants (see **Section 3.4**) will continue to depress FCI scores for the function PLANTS (maintenance of characteristic plant communities). However, with the implementation of an invasive species management plan the score would be likely to improve. Several functions involve the variable Flood Prone Area (FPA), which measures the degree to which the stream is confined within a man-made channel or gully. Eleven of the 24 study transects sampled in 2017 were scored as 4, defined as "FPA is confined and <1.5 bankfull width", indicating that the stream reach was confined in a gully. Discharge from MAR-5 has evidently scoured the channel in numerous areas, and continues to aggravate the gullying problem. However, the construction of a three-way flow splitter box

in 2017 and subsequent distribution of water into a secondary channel and tertiary pond has markedly improved the channeling problem and distributed the flow over a larger area.

4. SUMMARY

The initiation of water discharge from MAR-5 into the Gila River in August 2015 created a strip of wetland, called the "wetted area", that varied in width and degree of saturation with the amount of discharge and distance from the source. The pre-discharge vegetation of the area was a sparse collection of upland woody shrubs (four-wing saltbush, mesquite, jimmyweed, desert broom) with desert forbs (*Atriplex rosea, Tiquilia plicata,* and Russian thistle) and Bermudagrass. Saltcedar and Athel Tamarix were present at low cover. There were no cattails. After a few months of discharge, the water was turned off and the area was re-sampled in late November-early December 2015, by which time the cover of Bermudagrass had increased almost ten-fold, barnyard grass had become common, and the woody shrubs had increased in cover and density.

The area was re-sampled a year later in November-December 2016. Bermudagrass and barnyard grass continued to increase in cover, while cattails and the grass Mexican sprangletop (*Leptochloa fusca*) became common. Russian thistle was very common, and had increased in cover from 1.6 percent before discharge to 7.0 percent. Jimmyweed and the invasive saltcedar increased in cover, density, and volume. Thousands of saltcedar recruits had appeared since the previous year.

The data recorded in November 2017 showed a continuation of these trends. The grasses Bermudagrass, barnyard grass, and Mexican sprangletop together with cattails contributed over 50-percent cover, as contrasted to the total herbaceous cover of 8.3 percent in June 2015. Shrub cover for most species was steady or had declined slightly, except for saltcedar. The density of saltcedars had increased from 11 to 352 per hectare over the period June 2015 to November 2017.

Vegetation cover decreases with distance downstream from the MAR-5 discharge site, from an average cover of 86 percent in the six transects closest to MAR-5 to 33 percent in the farthest six. The most distant transect (Transect 37) had only 11-percent vegetation cover in November 2017.

The modification to the MAR-5 discharge facility in 2017 resulted in an increase in the wetted area from 53.9 to 123.4 acres; however, the amount of discharge was not increased.

Future discharge of water will probably result in increased production of vegetation in the wetted area, especially of cattails, Bermudagrass, barnyard grass, saltcedar, and mesquite. Upland woody species, including jimmyweed, desert broom, and saltbush, may decline in the wetted area because they cannot tolerate frequent inundation (Stromberg 1993). More desirable species, such as Goodding's willow, may require a shorter dry period to become established and persist (Lite and Stromberg 2005, Stromberg 1997).

5. REFERENCES

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FIGURES

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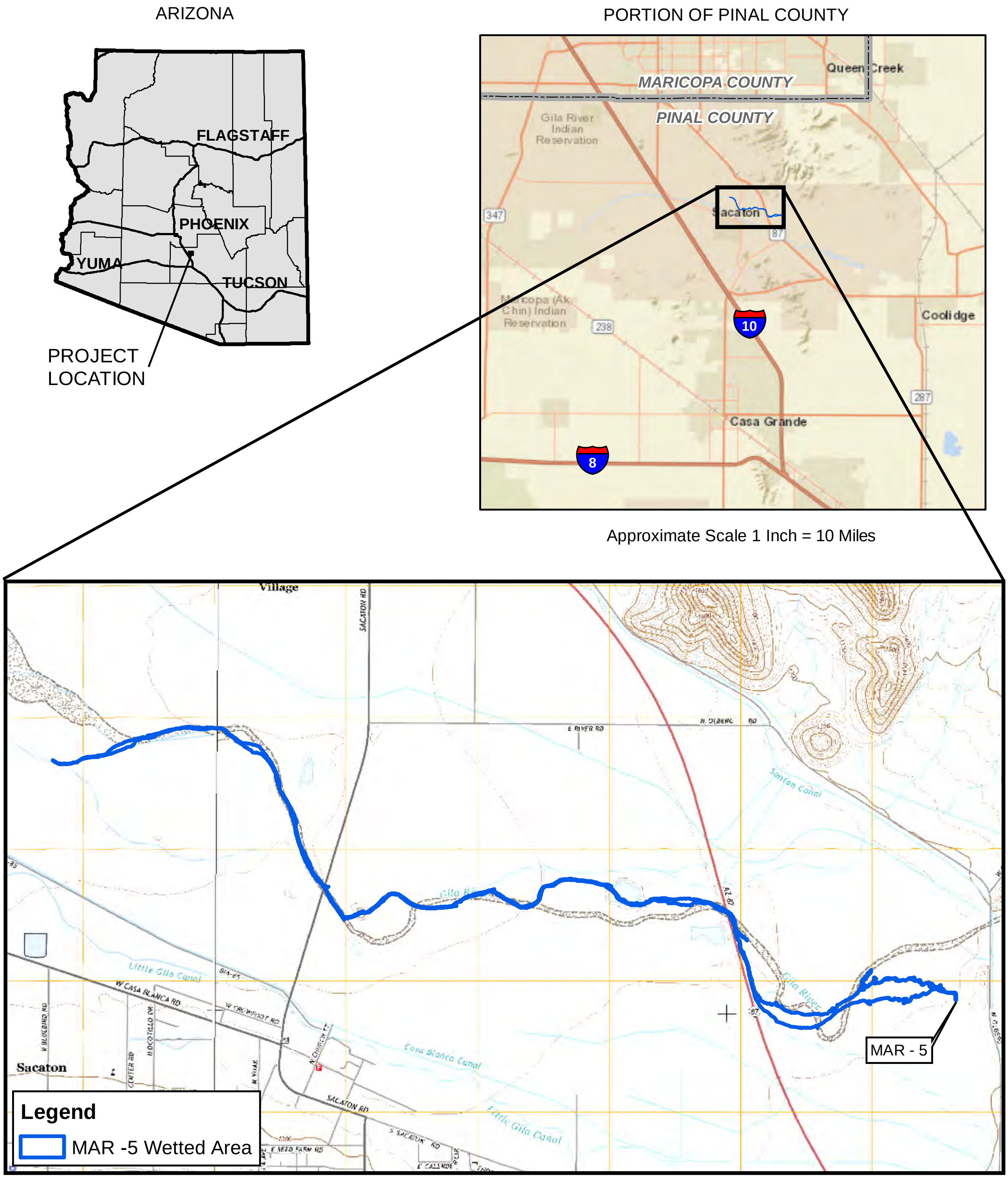

MAR-5 Wetted Area in
T4S, R6E, Portions of Sections 8-11, 13, and 14,
Pinal County, Arizona,
Sacaton and Gila Butte SE USGS 7.5' Quadrangles (2014)
Image Source: ArcGIS Online, World Street Map

WestLand Resources

N

0 1,800 3,600 Feet

0 600 1,200 Meters

RESOLUTION COPPER GRIC MAR-5

2017 Vegetation Monitoring Memo

VICINITY MAP

Figure 1

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WestLand Resources

T4S, R6E, Portions of Sections 9-11, 13, and 14,
Pinal County, Arizona,
Gila Butte and Sacaton USGS 7.5' Quadrangles
Projection: UTM NAD83, Zone 12
Photo Source: ArcGIS Online

0 600 1,200 Feet

0 200 400 Meters

N

Legend

- Stake Locations
- Transect Locations
- MAR 5 100cfs Predicted Wetted Area

RESOLUTION COPPER GRIC MAR - 5

2017 Vegetation Monitoring Memo

VEGETATION MONITORING TRANSECTS - JUNE 2015

Figure 2

WestLand Resources

Wetted Area found within:
T4S, R6E, Portions of Sections 8-11, 13, and 14,
Pinal County, Arizona.
Image Source: 2015 USDA NAIP Orthophoto
Data Sources: BLM PLSS section data, GRIC BIA
Allotment data provided by Paul Shorthair, Land Use Ordinance Officer.
Department of Land Use Planning and Zoning, Gila River Indian Community.
We received 4 scanned images from Paul Shorhair. They were rectified to
the NAIP 2015 imagery and the red lines on these maps were delineated
as BIA Allotment Lines

N

0 800 1,600 Feet

0 0.25 0.5 Miles

Legend

- Access Point
- Transcect Point 2016
- AccessRoute
- Transect Line 2016
- Approximate BIA Allotment Lines
- MAR -5 Wetted Area
- PLSSFirstDivision (Sections)

RESOLUTION COPPER GRIC MAR - 5

2017 Vegetation Monitoring Memo

VEGETATION MONITORING TRANSECTS - NOVEMBER 2016

Figure 3

Path: M:\Jobs\800's\807.131\ENV\GRIC\Gric_MAR5_2017VegMonitoringMemo\MXD\Fig04_GRIC_MAR_5_Vegetation_Monitoring.mxd

Date: 3/21/2018 User: rwitzke

T4S, R6E, Portions of Sections 8 - 14,
Pinal County, Arizona.
Gila Butte SE and Sacaton USGS 7.5' Quadrangles
Image Source: Pleiades Satellite Imagery 10/28/2017

Legend

Transect Line

MAR-5 Wetted Area

WestLand Resources

0 750 1,500 Feet

0 250 500 Meters

N

RESOLUTION COPPER GRIC MAR-5

2017 Vegetation Monitoring Memo

VEGETATION MONITORING TRANSECTS - NOVEMBER 2017

Figure 4

APPENDIX A

Repeat Photographic Documentation of Vegetation Monitoring Transects

Photo 1. Transect 1a, 10 degrees. June 2015

Photo 2. Transect 1a, 90 degrees. November 2015

Photo 3. Transect 1a, 90 degrees. November/December 2016

Photo 4. Transect 1a, 10 degrees. November 2017

WestLand Resources

Repeat Photographs of Vegetation Monitoring Transects
Appendix A

Photo 5. Transect 2a, 23 degrees. June 2015

Photo 6. Transect 2a, 23 degrees. November 2015

Photo 7. Transect 2a, 340 degrees. November 2016

Photo 8. Transect 2a, 345 degrees. November 2017

Photo 9. Transect 3a, 10 degrees. June 2015

Photo 10. Transect 3a, 10 degrees. November 2015

Photo 11. Transect 3a, 10 degrees. November 2016

Photo 12. Transect 3a, 10 degrees. November 2017

Photo 13. Transect 4a, 342 degrees. June 2015

Photo 15. Transect 4a, 340 degrees. November 2016

Photo 14. Transect 4a, 315 degrees. November 2015

Photo 16. Transect 4a, 315 degrees. November 2017

Photo 17. Transect 5a, 0 degrees. June 2015

Photo 18. Transect 5a, 0 degrees. November 2015

Photo 19. Transect 5a, 0 degrees. November 2016

Photo 20. Transect 5a, 330 degrees. November 2017

Photo 21. Transect 6a, 340 degrees. June 2015

Photo 22. Transect 6a, 340 degrees. November 2016

Photo 23. Transect 6a, 340 degrees. November 2016

Photo 24. Transect 6a, 340 degrees. November 2017

Photo 25. Transect 7a, 158 degrees. June 2015

Photo 27. Transect 7a, 158 degrees. November 2016

Photo 26. Transect 7a, 158 degrees. November 2015

Photo 28. Transect 7a, 158 degrees. November 2017

Photo 29. Transect 8a, 80 degrees. June 2015

Photo 30. Transect 8a, 80 degrees. November 2015

Photo 31. Transect 8a, 80 degrees. November 2016

Photo 32. Transect 8a, 30 degrees. November 2017

Photo 33. Transect 9a, 72 degrees. June 2015

Photo 34. Transect 9a, 72 degrees. November 2015

Photo 35. Transect 9a, 72 degrees. November 2016

Photo 36. Transect 9a, 60 degrees. November 2017

Photo 37. Transect 10a, 86 degrees. June 2015

Photo 38. Transect 10a, 90 degrees. November 2015

Photo 39. Transect 10a, 90 degrees. November 2016

Photo 40. Transect 11a, 82 degrees. June 2015

Photo 41. Transect 11a, 90 degrees. November 2015

Photo 42. Transect 11a, 90 degrees. November 2016

Photo 43. Transect 12a, 67 degrees. June 2015

Photo 44. Transect 12a, 67 degrees. November 2015

Photo 45. Transect 12a, 67 degrees. November 2016

Photo 46. Transect 12a, 67 degrees. November 2017

Photo 47. Transect 13a, 5 degrees. June 2015

Photo 48. Transect 13a, 5 degrees. November 2015

Photo 49. Transect 13a, 5 degrees. November 2016

Photo 50. Transect 13a, 5 degrees. November 2017

Photo 51. Transect 14a, 0 degrees. June 2015

Photo 52. Transect 14a, 0 degrees. November 2015

Photo 53. Transect 14a, 0 degrees. November 2016

Photo 54. Transect 14a, 340 degrees. November 2016

Photo 55. Transect 15a, 350 degrees. June 2015

Photo 57. Transect 15a, 350 degrees. November 2016

Photo 56. Transect 15a, 350 degrees. November 2015

Photo 58. Transect 15a, 340 degrees. November 2017

Photo 59. Transect 17a, 40 degrees. June 2015

Photo 61. Transect 17a, 40 degrees. November 2016

Photo 60. Transect 17a, 40 degrees. November 2015

Photo 62. Transect 17a, 10 degrees. November 2017

Photo 63. Transect 19a, 320 degrees. June 2015

Photo 65. Transect 19a, 320 degrees. November 2016

Photo 64. Transect 19a, 320 degrees. November 2015

Photo 66. Transect 19a, 305 degrees. November 2017

Photo 67. Transect 22a, 335 degrees. June 2015

Photo 68. Transect 22a, 335 degrees. November 2015

Photo 69. Transect 22a, 335 degrees. November 2016

Photo 70. Transect 22a, 310 degrees. November 2017

Photo 71. Transect 24a, 350 degrees. June 2015

Photo 72. Transect 24a, 350 degrees. November 2015

Photo 73. Transect 24a, 350 degrees. November 2016

Photo 74. Transect 24a, 340 degrees. November 2017

Photo 75. Transect 25a, 10 degrees. June 2015

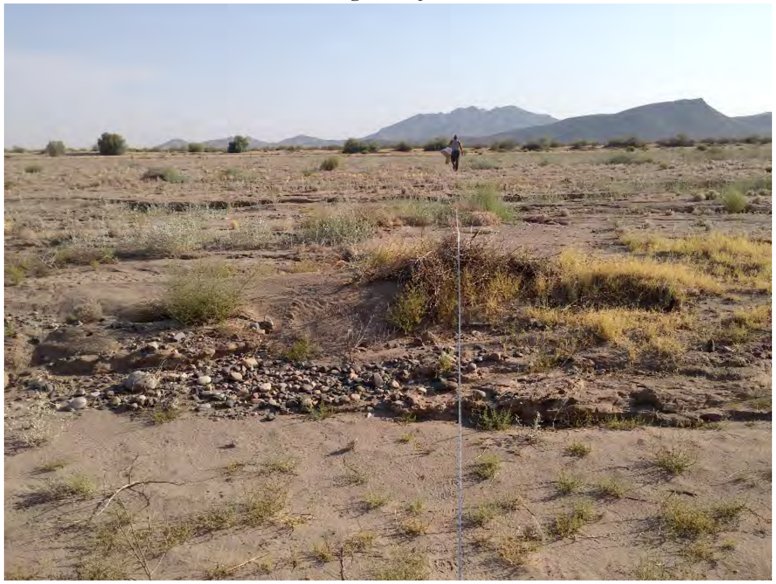

Photo 76. Transect 25a, 10 degrees. November 2015

Photo 77. Transect 25a, 10 degrees. November 2016

Photo 78. Transect 27a, 328 degrees. June 2015

Photo 79. Transect 27a, 328 degrees. November 2015

Photo 80. Transect 27a, 328 degrees. November 2016

Photo 81. Transect 27a, 320 degrees. November 2017

Photo 82. Transect 28a, 333 degrees. June 2015

Photo 83. Transect 28a, 333 degrees. November 2015

Photo 84. Transect 28a, 333 degrees. November 2016

Photo 85. Transect 28a, 340 degrees. November 2017

Photo 86. Transect 31a, 50 degrees. June 2015

Photo 87. Transect 31a, 50 degrees. November 2015

Photo 88. Transect 31a, 50 degrees. November 2016

Photo 89. Transect 31a, 60 degrees. November 2017

Photo 90. Transect 33a, 54 degrees. June 2015

Photo 91. Transect 33a, 54 degrees. November 2015

Photo 92. Transect 33a, 54 degrees. November 2016

Photo 93. Transect 33a, 60 degrees. November 2017

Photo 94. Transect 35a, 48 degrees. June 2015

Photo 95. Transect 35a, 48 degrees. November 2015

Photo 96. Transect 35a, 48 degrees. November 2016

Photo 97. Transect 35a, 40 degrees. November 2017

Photo 98. Transect 36a, 324 degrees, June 2015

Photo 99. Transect 36a, 324 degrees. November 2015

Photo 100. Transect 36a, 20 degrees. November 2016

Photo 101. Transect 36a, 20 degrees. November 2017

Photo 102. Transect 37a, 0 degrees. June 2015

Photo 104. Transect 37a, 0 degrees. November 2016

Photo 103. 37a, 0 degrees. November 2015

Photo 105. Transect 37a, 10 degrees. November 2017

APPENDIX B

Table 2 from Tres Rios del Norte (Pima County, Arizona) Ecosystem Restoration Functional Assessment Using HGM, December 2003, Analyses, Results, and Documentation Draft Report

Table 2. Functions in the Arizona Riverine HGM Model

Code	Name	Description
CHANNELDYN	Function 1: Maintenance of Characteristic Channel Dynamics	Physical processes and structural attributes that maintain characteristic channel dynamics. These include flow characteristics, bedload, in-channel coarse woody debris, and potential coarse woody debris inputs, channel dimensions, and other physical features (e.g. bank vegetation, slope).
WATSTORENR	Function 2: Dynamic Surface Water Storage/Energy Dissipation	Dynamic water storage and dissipation of energy at bankfull and greater discharges. These are a function of channel width, depth, bedload, bank roughness (coarse woody debris, vegetation, etc.), presence and number of in-channel coarse woody debris jams, and connectivity to off-channel pits, ponds, and secondary channels.
WATSTORLNG	Function 3: Long Term Surface Water Storage	The capability of a wetland to temporarily store (retain) surface water for long durations; associated with standing water not moving over the surface. Water sources may be overbank flow, overland flow, and/or channelized flow from uplands, or direct precipitation.
WATSTORSUB	Function 4: Dynamic Subsurface Water Storage	Availability of water storage beneath the wetland surface. Storage capacity becomes available due to periodic drawdown of water table.
NUTRIENT	Function 5: Nutrient Cycling	Abiotic and biotic processes that convert elements from one form to another; primarily recycling processes.
ELEMENTS	Function 6: Detention of Imported Elements and Compounds	The detention of imported nutrients, contaminants, and other elements or compounds.
DETPARTICL	Function 7: Detention of Particles	Deposition and detention of inorganic and organic particulates (>0.45 um) from the water column, primarily through physical processes.
PLANTS	Function 8: Maintain Characteristic Plant Communities	Species composition and physical characteristics of living plant biomass. The emphasis is on the dynamics and structure of the plant community as revealed by the species of TVVs, shrubs, seedlings, saplings, and herbs and by the physical characteristics of the vegetation.
HABSTRUCT	Function 9: Maintain Spatial Structure of Habitat	The capacity of a wetland to support animal populations and guilds by providing heterogeneous habitats.
INTERSPERS	Function 10: Maintain Interspersion and Connectivity	The capacity of the wetland to permit aquatic organisms to enter and leave the wetland via permanent of ephemeral surface channels, overbank flow, or unconfined hyporheic gravel aquifers. The capacity of the wetland to permit access of terrestrial or aerial organisms to contiguous areas of food and cover.

APPENDIX C

Functional Capacity Index (FCI) Scores of Functions Evaluated, for all Sampling Periods

Appendix C. Functional Capacity Index (FCI) Scores[1] of Functions Evaluated for all Sampling Periods[2]

Transect	CHANNELDYN	WATSTORENR	WATSTORLNG	WATSTORSUB	NUTRIENT	ELEMENTS	DETPARTICL	PLANTS	HABSTRUCT	INTERSPERS	Average
November-December 2015											
1	-	-	-	-	-	-	-	-	-	-	-
2	0.25	0.57	0.50	0.50	0.13	0.35	0.28	0.23	0.23	0.23	0.33
3	0.25	0.57	0.50	0.50	0.08	0.30	0.28	0.20	0.20	0.23	0.31
4	0.50	1.000	0.50	0.50	0.37	0.41	0.67	0.62	0.63	0.52	0.57
5	0.25	0.55	0.50	0.50	0.07	0.31	0.28	0.14	0.20	0.23	0.30
6	0.58	0.55	0.50	0.50	0.07	0.31	0.32	0.22	0.21	0.23	0.35
7	0.50	0.59	0.50	0.50	0.28	0.40	0.34	0.22	0.24	0.23	0.38
8	0.50	0.56	0.50	0.50	0.08	0.32	0.31	0.27	0.23	0.23	0.35
9	0.50	0.65	0.60	0.50	0.19	0.39	0.45	0.13	0.23	0.25	0.39
12	0.50	0.61	0.69	0.50	0.04	0.25	0.44	0.10	0.23	0.25	0.36
13	0.50	0.55	0.50	0.50	0.02	0.30	0.30	0.12	0.22	0.23	0.32
14	0.67	0.73	0.50	0.50	0.04	0.31	0.42	0.21	0.23	0.23	0.38
15	0.83	0.99	0.50	0.50	0.03	0.30	0.67	0.33	0.64	0.71	0.55
17	0.83	0.99	0.50	0.50	0.03	0.31	0.67	0.00	0.55	0.71	0.51
19	0.67	1.000	0.50	0.50	0.04	0.30	0.68	0.00	0.66	0.71	0.51
22	0.83	0.99	0.50	0.50	0.05	0.32	0.68	0.31	0.57	0.71	0.55
24	0.83	0.99	0.50	0.50	0.05	0.31	0.68	0.20	0.67	0.71	0.55
27	-	-	-	-	-	-	-	-	-	-	-
28	0.83	0.99	0.50	0.50	0.06	0.33	0.68	0.00	0.18	0.25	0.43
31	0.83	0.99	0.50	0.50	0.04	0.27	0.67	0.07	0.23	0.23	0.43
33	0.83	0.99	0.50	0.50	0.06	0.32	0.67	0.10	0.23	0.23	0.44
35	0.83	0.99	0.50	0.50	0.08	0.31	0.67	0.00	0.65	0.64	0.52
36	0.83	0.99	0.50	0.50	0.04	0.30	0.67	0.16	0.60	0.60	0.52
37	0.83	0.99	0.50	0.50	0.06	0.33	0.67	0.20	0.62	0.52	0.52
Average	**0.64**	**0.81**	**0.51**	**0.50**	**0.09**	**0.32**	**0.52**	**0.17**	**0.38**	**0.40**	**0.44**
November-December 2016											
1	-	-	-	-	-	-	-	-	-	-	-
2	0.58	0.66	0.84	0.50	0.30	0.53	0.45	0.30	0.23	0.25	0.46
3	0.58	0.65	0.84	0.50	0.22	0.46	0.44	0.29	0.23	0.25	0.45
4	0.58	0.72	0.84	0.50	0.57	0.68	0.48	0.32	0.23	0.25	0.52

Appendix C. Functional Capacity Index (FCI) Scores[1] of Functions Evaluated for all Sampling Periods[2]

Transect	CHANNELDYN	WATSTORENR	WATSTORLNG	WATSTORSUB	NUTRIENT	ELEMENTS	DETPARTICL	PLANTS	HABSTRUCT	INTERSPERS	Average
13	0.58	0.62	0.97	0.50	0.05	0.46	0.43	0.26	0.22	0.25	0.44
14	0.67	0.79	0.97	0.50	0.13	0.50	0.56	0.27	0.23	0.25	0.49
15	1.00	1.00	0.97	0.50	0.24	0.58	0.84	0.65	0.64	0.78	0.73
17	1.00	1.00	0.97	0.50	0.04	0.46	0.82	0.89	0.64	0.78	0.71
19	1.00	1.00	0.97	0.50	0.08	0.48	0.82	0.55	0.63	0.78	0.68
22	1.00	1.00	0.97	0.50	0.07	0.48	0.82	0.88	0.63	0.78	0.72
24	1.00	1.00	0.97	0.50	0.09	0.46	0.83	0.75	0.65	0.78	0.71
27	1.00	1.00	0.97	0.50	0.24	0.60	0.84	0.76	0.63	0.78	0.74
28	0.83	1.00	0.91	0.50	0.16	0.50	0.83	0.22	0.23	0.28	0.55
31	0.83	1.00	0.91	0.50	0.28	0.56	0.83	0.23	0.22	0.25	0.57
33	1.00	1.00	0.97	0.50	0.25	0.54	0.84	0.25	0.23	0.25	0.59
35	1.00	1.00	0.91	0.50	0.05	0.41	0.83	0.72	0.66	0.71	0.68
36	0.83	1.00	0.84	0.50	0.06	0.41	0.80	0.58	0.59	0.67	0.63
37	0.83	1.00	0.84	0.50	0.22	0.52	0.82	0.54	0.59	0.60	0.65
Average	**0.84**	**0.94**	**0.92**	**0.50**	**0.18**	**0.51**	**0.72**	**0.50**	**0.44**	**0.51**	**0.61**
November 2017											
1	0.25	0.67	0.77	0.50	0.31	0.52	0.45	0.31	0.24	0.25	0.43
2	0.25	0.56	0.65	0.50	0.15	0.37	0.29	0.29	0.24	0.23	0.35
3	0.25	0.55	0.65	0.50	0.05	0.36	0.28	0.31	0.23	0.23	0.34
4	0.25	0.57	0.65	0.50	0.15	0.41	0.30	0.30	0.24	0.23	0.36
5	0.42	0.60	0.77	0.50	0.22	0.54	0.32	0.31	0.22	0.23	0.41
6	0.50	0.55	0.65	0.50	0.04	0.36	0.30	0.31	0.23	0.23	0.37
7	0.50	0.58	0.65	0.50	0.21	0.45	0.32	0.31	0.23	0.23	0.40
8	0.50	0.55	0.65	0.50	0.08	0.35	0.31	0.27	0.23	0.23	0.37
9	0.25	0.60	0.65	0.50	0.22	0.49	0.29	0.29	0.22	0.23	0.38
12	0.25	0.55	0.65	0.50	0.01	0.36	0.27	0.31	0.22	0.23	0.34
13	0.25	0.55	0.65	0.50	0.05	0.36	0.28	0.29	0.23	0.23	0.34
14	0.50	0.72	0.65	0.50	0.00	0.35	0.39	0.27	0.22	0.23	0.38
15	0.50	0.99	0.65	0.50	0.07	0.37	0.65	0.89	0.65	0.71	0.60
17	0.50	0.99	0.65	0.50	0.04	0.37	0.65	0.85	0.64	0.71	0.59
19	0.50	1.00	0.65	0.50	0.14	0.43	0.66	0.75	0.64	0.71	0.60

Appendix C. Functional Capacity Index (FCI) Scores[1] of Functions Evaluated for all Sampling Periods[2]

Transect	CHANNELDYN	WATSTORENR	WATSTORLNG	WATSTORSUB	NUTRIENT	ELEMENTS	DETPARTICL	PLANTS	HABSTRUCT	INTERSPERS	Average
22	0.50	0.99	0.65	0.50	0.07	0.37	0.66	0.84	0.66	0.71	0.59
24	0.50	1.00	0.65	0.50	0.15	0.41	0.68	0.80	0.69	0.71	0.61
27	0.50	1.00	0.65	0.50	0.31	0.54	0.68	0.82	0.65	0.71	0.64
28	0.50	1.00	0.65	0.50	0.23	0.45	0.71	0.27	0.25	0.25	0.48
31	0.50	1.00	0.65	0.50	0.22	0.47	0.67	0.25	0.23	0.23	0.47
33	0.50	1.00	0.77	0.50	0.12	0.43	0.78	0.23	0.22	0.25	0.48
35	0.50	0.99	0.58	0.50	0.02	0.33	0.64	0.81	0.63	0.64	0.56
36	0.50	1.00	0.69	0.50	0.04	0.33	0.77	0.67	0.61	0.67	0.58
37	0.50	1.00	0.69	0.50	0.06	0.34	0.77	0.50	0.60	0.60	0.56
Average	**0.42**	**0.80**	**0.66**	**0.50**	**0.12**	**0.41**	**0.51**	**0.47**	**0.38**	**0.40**	**0.47**

1 Scores range from 0 to 1, based on similarity to well-functioning reference sites; see **Appendix B** for description of functions.

2 Rows with no scores were not sampled during that period.

APPENDIX B

AGFD Letter to Resolution Copper on the Lower San Pedro River Wildlife Area In-Lieu Fee Program

(Dated April 15, 2019)

April 15, 2019

Vicki Peacey
Senior Manager Permits & Approvals
Resolution Copper
102 Magma Heights
Superior, AZ 85173

Ms. Peacey,

The Department maintains an In-Lieu-Fee (ILF) program for Army Corps of Engineers (ACOE) 404 permit mitigation in an effort to facilitate economic development while ensuring conservation of Arizona's natural resources. One of the ILF programs maintained by the Department is located on the Lower San Pedro River Wildlife Area (LSPRWA). Your organization has expressed interest in purchasing mitigation credits within this ILF site. As we have discussed, all Advanced Credits at our LSPRWA ILF site have been sold or obligated for sale.

That said, the first set of Project Specific Credits will become available after the site has met established performance standards for the first 50 Advanced Credits and full approval of the Development Plan is obtained from the ACOE. At this time, we anticipate full sale of the Advanced Credits will be completed by the end of calendar 2019 with the Development Plan submitted the ACOE in calendar 2020. The full conservation of the LSPRWA site will be implemented in phases to ensure ecological performance standards are being met and ACOE approvals obtained for each phase. The Department's LSPRWA has five phases of 130 credits each accounting for a total of 650 credits. These credit releases will be available for purchase over time and will be available to anyone requiring mitigation credits.

I want to thank you and your staff for taking the time to make the Department's staff aware of your program development and look forward to a continued excellent relationship with Resolution. Further, as the Department's obligation for prior credit commitments are fully met, the Department will consider making future credits available to Resolution Copper and other entities in need of mitigation credits. Additionally, the Department would like to offer assistance in working with Resolution Copper to investigate other mitigation opportunities as a result of project implementation of your mining plan of development,

Again, thanks for your organization's positive working approach with the Department.

Sincerely,

Jim deVos

Jim deVos
Assistant Director Wildlife Management Division

Cc:

Craig McMullen, Assistant Director Field Operations Division
Jay Cook, Regional Supervisor Mesa
Keith Knutson, Chief Wildlife Contracts
Clayton Crowder, Chief Habitat Branch

AGFD #M19-04014607

APPENDIX E. ALTERNATIVES IMPACT SUMMARY

Summary of Impacts

One of the core processes of any environmental impact statement (EIS)-level NEPA analysis is public outreach early in the project, which serves to inform the public, stakeholders, tribes, and other Federal, state, and municipal agencies of the nature of the proposed action and provides an opportunity for interested persons to ask questions of the lead Federal agency and to express thoughts or concerns they may have regarding the action. This process is referred to as “scoping” (40 CFR 1501.7).

The scoping process also serves as a means for the lead agency to gather initial ideas for alternative actions to the project that may accomplish the same overall purpose but possibly be less damaging to the environment. And, lastly, the public scoping process is essential to initially identifying potential effects on resources and other issues that will be analyzed in detail in the EIS.

The scoping process for this EIS is detailed in the “Resolution Copper Project and Land Exchange Environmental Impact Statement Scoping Report” (Scoping Report) available here: https://www.resolutionmineeis.us/documents/usfs-tonto-scoping-report.

The information gathered during the scoping process was subsequently analyzed by members of the project team and distilled into 14 major issues for consideration in the EIS. Nearly of these major issues include sub-issues to further focus the analysis, and all included specific “factors for analysis” as a means to gauge and compare effects. Details of how comments gathered during scoping were distilled into primary issues and sub-issues are documented in the “Resolution Copper Project and Land Exchange Environmental Impact Statement: Final Summary of Issues Identified Through Scoping” (Issues Report), available at https://www.resolutionmineeis.us/documents/usfs-tonto-issues-report-201711.

Table E-1 below provides a complete listing of primary issues and sub-issues that guided the effects analysis and a summary of impacts by project alternative. Please note that this table is organized by major issue as derived from the scoping process and the issues analysis, rather than by the section of the draft EIS (DEIS) in which that resource is addressed; the information in the left-most column points the reader to where in the DEIS the corresponding analysis may be found.

Impacts and differences between alternatives are highlighted at the end of chapter 2 at a high level. While appendix E also summarizes impacts, it is specifically intended to provide a crosswalk between the original issues/sub-issues and the actual results of the analysis, and to provide a more detailed yet succinct comparison between alternatives.

As documented in the footnotes to table E-1, during course of the impacts analysis certain sub-issues were modified or dismissed altogether for the specific reasons cited in each footnote.

Table E-1. Alternatives impact summary

DEIS Section	Issue Category	Alternative 1 – No Action	Alternative 2 – Near West Proposed Action	Alternative 3 – Near West – Ultrathickened	Alternative 4 – Silver King	Alternative 5 – Peg Leg	Alternative 6 – Skunk Camp
	Issue 1A: Tribal Values and Concerns – Disturbance to Tribal Values and Practices from Combined Resource Disturbance						
3.14.4.2 and 3.14.5	1A-1. Qualitative assessment of how cumulative resource disturbance impacts tribal values and spiritual practices.	Although under this alternative the Resolution Mine would not be developed, other ongoing or reasonably foreseeable transportation, utility, and other projects, and particularly large-scale mining operations such as the Pinto Valley Mine, the ASARCO Ripsey Wash tailings impoundment, and potential mine development in the Copper Butte area, would continue to be likely to adversely affect places and natural resources valued by Native Americans.	Development of the Resolution Mine under this or any other action alternative would directly and permanently damage the NRHP-listed *Chí'chil Biłdagoteel* Historic District TCP at the East Plant Site. In addition, as noted for the no action alternative, other large-scale mine development along with smaller transportation, utility, and private land development projects in the Superior region may adversely affect certain places and resources of value to Native Americans, including historic resource collection sites and culturally valued landforms and features.	Same as noted under Alternatives 1 and 2	Same as noted under Alternatives 1 and 2	Same as noted under Alternatives 1 and 2	Same as noted under Alternatives 1 and 2

DEIS Section	Issue Category	Alternative 1 – No Action	Alternative 2 – Near West Proposed Action	Alternative 3 – Near West – Ultrathickened	Alternative 4 – Silver King	Alternative 5 – Peg Leg	Alternative 6 – Skunk Camp
	Issue 1B: Tribal Values and Concerns – Impacts to Tribal Valued Resources at Oak Flat and Apache Leap						
3.7.1.4 and 3.14.4.2	1B-1. Quantitative assessment of number of sacred springs or other discrete sacred sites impacted.	Under the no action alternative most sacred sites would remain unaltered. However, Resolution Copper would continue dewatering activities at the East Plant Site. As described in DEIS Section 3.7.1, it is possible under the no action alternative that as many as six sacred springs could be adversely affected by drawdown due to continued mine dewatering.	In addition to impacts as under the no action alternative, water table drawdown caused by block caving is anticipated to impact two additional springs in the Superior area. Three additional springs would be buried beneath the tailings impoundment, and two additional springs would be within the subsidence area. A total of 13 sacred springs are anticipated to be lost under Alternative 2.	Same as Alternative 2	In addition to the springs in and around the town of Superior that would be adversely impacted by dewatering and block caving activities at the East Plant Site, under the Silver King Alternative one additional spring would be buried beneath the tailings impoundment. A total of 11 sacred springs are anticipated to be lost under Alternative 4.	Under this alternative, although springs in and around the town of Superior would be adversely impacted by dewatering and block caving activities at the East Plant Site, analysis shows no additional springs at the tailings location would be impacted. A total of 10 sacred springs are anticipated to be lost under Alternative 5.	Under this alternative, although springs in and around the town of Superior would be adversely impacted by dewatering and block caving activities at the East Plant Site, analysis shows no additional springs at the tailings location would be impacted. A total of 10 sacred springs are anticipated to be lost under Alternative 6.

DEIS Section	Issue Category	Alternative 1 – No Action	Alternative 2 – Near West Proposed Action	Alternative 3 – Near West – Ultrathickened	Alternative 4 – Silver King	Alternative 5 – Peg Leg	Alternative 6 – Skunk Camp
3.12.4.1 and 3.14.4.2	1B-2. Qualitative assessment of the impacts on Native Americans of the desecration of land, springs, burials, and sacred sites.	Same as above with respect to springs. Other effects to lands, burials, and other features and places of value to Native Americans would not occur under the no action alternative.	Development of the Resolution Mine under this or any other action alternative would directly and permanently damage the NRHP-listed *Chí'chil Biłdagoteel* Historic District TCP at the East Plant site. Similarly, under all action alternatives mine activity and the visual effects of subsidence would be perceptible from within the Apache Leap SMA. Under Alternative 2 the tailings storage facility would be fully in view from Picketpost Mountain, a mountain sacred to Western Apache bands, and the presence of the nearly 500-foot high tailings would constitute an adverse visual effect on the landscape. Numbers and locations of burials would not be known until such sites are detected as a result of mine-related activities. One large TEKP would be impacted by the tailings storage facility.	Same as Alternative 2	Same as Alternative 2, with the exception of TEKPs. With Alternative 4, three TEKPs would be impacted by the tailings storage facility.	Effects from the East Plant Site and subsidence area would be the same as under Alternative 2. For Alternative 5, three TEKPs would be impacted by the tailings storage facility.	Effects from the East Plant Site and subsidence area would be the same as under Alternative 2. For Alternative 6, at this time TEKPs have not been identified, but may be through additional surveys.

DEIS Section	Issue Category	Alternative 1 – No Action	Alternative 2 – Near West Proposed Action	Alternative 3 – Near West – Ultrathickened	Alternative 4 – Silver King	Alternative 5 – Peg Leg	Alternative 6 – Skunk Camp
3.7.1.4, 3.12.4.2, and 3.14.4.2	1B-3. [REVISED][1] Qualitative assessment of traditional resource collection areas impacted.	No adverse effects to any traditional resource collection areas are foreseen. However, as noted in section 3.7.1, under the no action alternative six springs are anticipated to be impacted by continued dewatering, which may also adversely affect plant availability.	Under all action alternatives, one or more Emory oak groves at Oak Flat, used by tribal members for acorn collecting, will likely be lost. Other unspecified mineral and/or plant collecting locations are also likely to be affected; historically, medicinal and other plants are frequently gathered near springs and seeps, so drawdown of water at these locations may also adversely affect plant availability.	Same as Alternative 2	Impacts at the East Plant Site/Oak Flat would be the same as under Alternative 2. Other impacts to tribal values and concerns would be similar in context and intensity to those under Alternative 2; however, because the tailings storage facility would be in a different location, the specific impacts to potentially meaningful sites, resources, routes, and viewsheds would vary. See DEIS sections 3.11.4 (scenery), 3.12.4 (cultural resources), and 3.14.4 (tribal values) for detailed impact analyses specific Alternative 4.	Impacts at the East Plant Site/Oak Flat would be the same as under Alternative 2. Other impacts to tribal values and concerns would be similar in context and intensity to those under Alternative 2; however, because the tailings storage facility would be in a different location, the specific impacts to potentially meaningful sites, resources, routes, and viewsheds would vary. See DEIS sections 3.11.4 (scenery), 3.12.4 (cultural resources), and 3.14.4 (tribal values) for detailed impact analyses specific to Alternative 5.	Impacts at the East Plant Site/Oak Flat would be the same as under Alternative 2. Other impacts to tribal values and concerns would be similar in context and intensity to those under Alternative 2; however, because the tailings storage facility would be in a different location, the specific impacts to potentially meaningful sites, resources, routes, and viewsheds would vary. See DEIS sections 3.11.4 (scenery), 3.12.4 (cultural resources), and 3.14.4 (tribal values) for detailed impact analyses specific to Alternative 6.

[1] The original issue factor expected to be analyzed was: "Quantitative assessment of acres of traditional resource collection areas impacted." As locations for many traditional resource collection areas identified are sensitive, this was changed to a qualitative assessment rather than relying on acreage calculations.

DEIS Section	Issue Category	Alternative 1 – No Action	Alternative 2 – Near West Proposed Action	Alternative 3 – Near West – Ultrathickened	Alternative 4 – Silver King	Alternative 5 – Peg Leg	Alternative 6 – Skunk Camp
	Issue 2A: Socioeconomics – Impacts to Municipal Infrastructure						
3.13.4.2	2A-1. Quantitative assessment of change in employment, labor earnings and economic output over time, including direct and indirect effects	No impacts anticipated.	On average, the mine is projected to directly employ 1,523 workers, pay about $134 million per year in total employee compensation, and purchase about $546 million per year in goods and services. Including direct and multiplier effects, the proposed mine is projected to increase average annual economic value added in Arizona by about $1.0 billion	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2
3.13.4.2	2A-2. Quantitative assessment of change in tax revenues per year over time, including changes to payments in lieu of taxes (PILT)	No impacts anticipated.	The proposed mine is projected to generate an average of between $88 and $113 million per year in state and local tax revenues and would also produce substantial revenues for the Federal Government, estimated at over $200 million per year.	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2

DEIS Section	Issue Category	Alternative 1 – No Action	Alternative 2 – Near West Proposed Action	Alternative 3 – Near West – Ultrathickened	Alternative 4 – Silver King	Alternative 5 – Peg Leg	Alternative 6 – Skunk Camp
3.13.4.2	2A-3. Quantitative assessment of change in demand and cost for local road maintenance over time	No impacts anticipated.	Construction and operations of the proposed mine could affect both the Town of Superior's costs to maintain its network of streets and roads as well as those of Pinal County. However, these impacts are difficult to predict as no precise figures have been available that break out road maintenance costs vs. total municipal expenditures. Based on projected changes in the effective population served by Pinal County, the proposed mine could increase the total costs of county service provisions (of which maintenance of County roads is one expenditure) by approximately $3 million to $6 million per year.	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2

DEIS Section	Issue Category	Alternative 1 – No Action	Alternative 2 – Near West Proposed Action	Alternative 3 – Near West – Ultrathickened	Alternative 4 – Silver King	Alternative 5 – Peg Leg	Alternative 6 – Skunk Camp
3.13.4.2	2A-4. Qualitative assessment of change in demand and cost for emergency services over time	No impacts anticipated.	The Town of Superior anticipates that its costs of providing services related to public safety (police and fire protection) would increase by about 50% if and when the proposed mine becomes fully operational. Based on Superior's current expenditures to provide these services, this would represent an increase of about $375,000 per year in costs for the Town. Resolution Copper has entered into an agreement with the Town of Superior to provide $1.65 million to support emergency response services by the Town over the period from 2016 to 2021.	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2

DEIS Section	Issue Category	Alternative 1 – No Action	Alternative 2 – Near West Proposed Action	Alternative 3 – Near West – Ultrathickened	Alternative 4 – Silver King	Alternative 5 – Peg Leg	Alternative 6 – Skunk Camp
3.13.4.2	2A-5. Quantitative assessment of change in tourism and recreation revenue over time	No impacts anticipated.	The effects of the proposed mine at the East Plant Site would reduce the number of hunting days per year by approximately 188, and result in a direct reduction of $10,510 annual wildlife-related recreation spending in the local economy, which would equal a nominal value of $630,480 over the 60-year life of the proposed mine. The Near West tailings alternative site would reduce the number of hunting days per year on the site by approximately 1,200, amounting to a reduction in direct wildlife-related recreation expenditures of $66,920 per year or $4.0 million over a 60-year mine life.	Same as Alternative 2.	Effects from East Plant Site are the same as Alternative 2. The Silver King alternative site would reduce the number of hunting days per year by approximately 1,078, and reduce the amount of direct wildlife-related recreation expenditures by about $60,368 per year or $3.6 million over a 60-year mine life.	Effects from East Plant Site are the same as Alternative 2. The Peg Leg alternative site would reduce the number of hunting days per year by approximately 219, and reduce the amount of direct wildlife-related recreation expenditures by about $12,254 per year or $735,269 over a 60-year mine life.	Effects from East Plant Site are the same as Alternative 2. The Skunk Camp alternative site would reduce the number of hunting days per year by approximately 1,269, and reduce the amount of direct wildlife-related recreation expenditures by about $70,554 per year or $4.2 million over a 60-year mine life.
	Issue 2B: Socioeconomics – Impacts to Property Values						
3.13.4.2	2B-1. Quantitative assessment of change in property values over time	No impacts anticipated.	Properties values within a 5-mile radius of the tailings storage facility would be reduced by approximately $3.1 million, a reduction of 4.1%.	Same as Alternative 2.	Property values within a 5-mile radius of the tailings storage facility would be reduced by approximately $5.5 million, a reduction of 10.6%.	Property values within a 5-mile radius of the tailings storage facility would be reduced by approximately $69,000, a reduction of 6.3%.	Property values within a 5-mile radius of the tailings storage facility would be reduced by $58,000, a reduction of 4.0%.

DEIS Section	Issue Category	Alternative 1 – No Action	Alternative 2 – Near West Proposed Action	Alternative 3 – Near West – Ultrathickened	Alternative 4 – Silver King	Alternative 5 – Peg Leg	Alternative 6 – Skunk Camp
	Issue 2C: Socioeconomics – Impacts to Groundwater Availability/Usability						
3.7.1.4	2C-1. Qualitative assessment of effect of reduced groundwater availability on property values	No impacts anticipated.	While drawdown caused by mine dewatering and block-caving could impact wells at Top-of-the-World and Superior, Resolution Copper has committed to mitigation (replacement of water sources) that would result in no net loss of water supplies.	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2
3.7.2.4; Appendix M	2C-2. Qualitative assessment of effect of reduced groundwater quality on property values	No impacts anticipated.	While concentrations of metals and other constituents (sulfate, total dissolved solids) are expected to increase above background concentrations due to seepage from the tailings storage facility, no concentrations above Arizona Aquifer Water Quality Standards are anticipated that would render downgradient water supplies unusable.	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2

DEIS Section	Issue Category	Alternative 1 – No Action	Alternative 2 – Near West Proposed Action	Alternative 3 – Near West – Ultrathickened	Alternative 4 – Silver King	Alternative 5 – Peg Leg	Alternative 6 – Skunk Camp
	Issue 2D: Socioeconomics – Impacts to Local and Regional Living Standards						
3.13.5	2D-1. Qualitative assessment of the ability to meet rural landscape expectations as expressed by Federal, state and local plans	No impacts anticipated.	Large-scale mining projects such as the Resolution Mine may also adversely affect what are considered desirable but less tangible qualities of a rural setting and lifestyle. Applicant-committed environmental protection measures would be effective at expanding the economic base of the local community and improving resident quality of life, and could partially offset the expected impacts.	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2
	2D-2. [DROPPED][2]						

[2] The original issue factor expected to be analyzed was: "Quantitative assessment of economic effects on amenity-based relocation." Based on the BBC Research and Consulting report titled *Socioeconomic Effects Technical Report: Resolution Copper Mine Environmental Impact Statement* (BBC 2018), amenity-based relocation in Pinal and Gila Counties was already low in comparison, for example, to Maricopa County. Development of the Resolution Mine is not expected to substantially alter existing conditions with respect to amenity-based resident populations or future relocations in these two counties.

DEIS Section	Issue Category	Alternative 1 – No Action	Alternative 2 – Near West Proposed Action	Alternative 3 – Near West – Ultrathickened	Alternative 4 – Silver King	Alternative 5 – Peg Leg	Alternative 6 – Skunk Camp
3.13.4.2	2D-3. Quantitative assessment of economic effects from change in visitor uses of Tonto National Forest and other public lands	No impacts anticipated.	The affected areas are used for a variety of activities, including OHV use, camping, and hunting, by visitors from outside Pinal County. AGFD estimates the East Plant Site and subsidence area would affect about 6 miles of public access motorized routes and eliminate 421 acres of dispersed camping. AGFD estimates that the Near West Tailings alternative would affect about 23 miles of public access motorized routes and eliminate 1,737 acres of dispersed camping	Same as Alternative 2.	Effects of the East Plant Site and subsidence area are the same as under Alternative 2. AGFD estimates that the Silver King tailings alternative would affect about 20 miles of public access motorized routes and eliminate 1,434 acres of dispersed camping.	Effects of the East Plant Site and subsidence area are the same as under Alternative 2. AGFD estimates that the Peg Leg tailings alternative would affect about 45 miles of public access motorized routes and eliminate 1,009 acres of dispersed camping (excluding pipeline corridors).	Effects of the East Plant Site and subsidence area are the same as under Alternative 2. AGFD estimates that the Skunk Camp tailings alternative would affect about 32 miles of public access motorized routes and eliminate 861 acres of dispersed camping (excluding pipeline corridors).
	Issue 3: Environmental Justice						
3.15.4.3	3-1. Quantitative assessment of economic effects on environmental justice communities and qualitative assessment of whether these effects are disproportionate.	Beneficial or adverse economic impacts to environmental justice populations would not occur, as the mine would not be developed and current land use would remain unchanged.	Overall, while both adverse and beneficial economic effects would impact environmental justice communities, they would not be disproportionately high or adverse.	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2

DEIS Section	Issue Category	Alternative 1 – No Action	Alternative 2 – Near West Proposed Action	Alternative 3 – Near West – Ultrathickened	Alternative 4 – Silver King	Alternative 5 – Peg Leg	Alternative 6 – Skunk Camp
3.15.4.3 (*Continued*)	3-1. Quantitative assessment of economic effects on environmental justice communities and qualitative assessment of whether these effects are disproportionate. (*Continued*)		All environmental justice communities would experience socioeconomic benefits such as an increase in tax revenues and direct and indirect employment opportunities. There would also be negative socioeconomic effects. The expected influx of new workers may lead to shortages of housing and/or pressures on municipal infrastructure such as roads, schools, and medical facilities, and may be accompanied by price increases. Property values may be affected by the proximity of the tailings storage facility. Adverse or beneficial economic effects from the mine would be most apparent in the environmental justice community of the town of Superior. A number of applicant-committed measures would increase quality of life and opportunities within the town of Superior, offsetting some negative effects.				

DEIS Section	Issue Category	Alternative 1 – No Action	Alternative 2 – Near West Proposed Action	Alternative 3 – Near West – Ultrathickened	Alternative 4 – Silver King	Alternative 5 – Peg Leg	Alternative 6 – Skunk Camp
3.15.4.3	3-2. Qualitative assessment of disproportionate effects of adverse resource impacts to environmental justice communities.	Disproportionate effects on environmental justice populations would not occur, as the mine would not be developed and current land use would remain unchanged.	The proposed East Plant Site, West Plant Site, area of subsidence, and auxiliary facilities would have disproportionately high and adverse impacts on the environmental justice community of the town of Superior for scenic resources and dark skies. In addition, impacts on cultural resources and tribal concerns and values would have a disproportionally adverse impact on Native American communities. Other environmental justice communities (with the exception of Native American communities) would not experience adverse impacts as a result of the proposed project because they would be located outside the geographic area of influence for most resources, or impacts are not disproportionately high or adverse on the community. For Alternative 2, the same impacts are true of the tailings storage facility.	Same as Alternative 2	Same as Alternative 2. For the Alternative 4 tailings storage facility, the scenic impacts from the Silver King alternative tailings storage would be felt most strongly in the town of Superior, due to the proximity and location of the facility.	Same as Alternative 2, but the Alternative 5 tailings storage facility would not impact any environmental justice communities.	Same as Alternative 2, but the Alternative 6 tailings storage facility would not impact any environmental justice communities.

DEIS Section	Issue Category	Alternative 1 – No Action	Alternative 2 – Near West Proposed Action	Alternative 3 – Near West – Ultrathickened	Alternative 4 – Silver King	Alternative 5 – Peg Leg	Alternative 6 – Skunk Camp
	Issue 4: Impacts to Cultural Resources						
	4-1. [DROPPED][3]						
	4-2. [DROPPED][4]						
3.12.4	4-3. Quantitative assessment of number of NRHP-eligible historic properties, sacred sites, and other landscape-scale properties, to be buried, destroyed, or damaged.	If, under this alternative, the GPO is not approved but the land exchange occurs, 31 NRHP-eligible sites and one TCP would be adversely affected. If the GPO is not approved and the land exchange does not occur, there would be no effect.	101 NRHP-eligible and 31 sites of currently undetermined eligibility would be adversely affected. One TCP at the East Plant Site would also be adversely affected.	Same as Alternative 2	Impacts would be similar to Alternative 2; 122 NRHP-eligible sites and 15 currently undetermined sites would be directly and adversely impacted. About 72% of this area has been fully pedestrian surveyed for cultural resources.	Impacts would be similar to Alternative 2; 125 NRHP-eligible sites and 27 currently undetermined sites would be directly and adversely impacted for the east pipeline option, and 114 NRHP-eligible sites and 11 currently undetermined sites would be directly and adversely impacted for the west pipeline option. Between 74% to 78% of the area has been fully pedestrian surveyed for cultural resources, depending on pipeline route.	Impacts would be similar to Alternative 2; 343 NRHP-eligible sites and 17 currently undetermined sites would be directly and adversely impacted for the south pipeline option, and 318 NRHP-eligible sites and 5 currently undetermined sites would be directly and adversely impacted for the north pipeline option. About 96% of this area has been fully pedestrian surveyed for cultural resources.

[3] The original issue factor expected to be analyzed was: “Qualitative assessment of the impacts to places of traditional and cultural significance to Native Americans including natural resources.” This is largely duplicated by issue factors 1B-1, 1B-2, and 1B-3.

[4] The original issue factor expected to be analyzed was: “Qualitative assessment of the impacts on other non-tribal communities in the region in terms of impacts on resources, such as historical townsites, cemeteries, mines, ranches, and homesteads.” Any historical sites are already incorporated into the analysis described by issue factor 4-3.

DEIS Section	Issue Category	Alternative 1 – No Action	Alternative 2 – Near West Proposed Action	Alternative 3 – Near West – Ultrathickened	Alternative 4 – Silver King	Alternative 5 – Peg Leg	Alternative 6 – Skunk Camp
3.12.4	4-4. Quantitative assessment of number of NRHP-eligible historic properties expected to be visually impacted.	If, under this alternative, the GPO is not approved but the land exchange occurs, 31 NRHP-eligible sites and one TCP would be adversely affected. If the GPO is not approved and the land exchange does not occur, there would be no effect.	In addition to direct impacts, historic properties within the indirect analysis area and atmospheric analysis area could be impacted visually. This includes 29 historic properties within the indirect analysis area (2 NRHP-listed, 8 NRHP-eligible, and 19 unevaluated), and 48 sites within the atmospheric analysis area.	Same as Alternative 2	In addition to direct impacts, historic properties within the indirect analysis area and atmospheric analysis area could be impacted visually. This includes 25 historic properties within the indirect analysis area (2 NRHP-listed, 11 NRHP-eligible, and 12 unevaluated), and 48 sites within the atmospheric analysis area.	In addition to direct impacts, historic properties within the indirect analysis area and atmospheric analysis area could be impacted visually. For the eastern pipeline route, this includes 44 historic properties within the indirect analysis area (2 NRHP-listed, 23 NRHP-eligible, and 19 unevaluated), and 48 sites within the atmospheric analysis area. For the western pipeline route, this includes 29 historic properties within the indirect analysis area (1 NRHP-listed, 16 NRHP-eligible, 12 unevaluated), and 48 sites within the atmospheric analysis area.	In addition to direct impacts, historic properties within the indirect analysis area and atmospheric analysis area could be impacted visually. For the northern pipeline route, this includes 25 historic properties within the indirect analysis area (2 NRHP-listed, 12 NRHP-eligible, and 11 unevaluated), and 45 sites within the atmospheric analysis area. For the southern pipeline route, this includes 41 historic properties within the indirect analysis area (2 NRHP-listed, 19 NRHP-eligible, 20 unevaluated), and 45 sites within the atmospheric analysis area.
3.4.4	4-5. Qualitative assessment of potential for vibrations to damage cultural resources within and adjacent to the project areas.	If the GPO is not approved and the land exchange does not occur, there would be no effect.	The vibration analysis indicates that within given levels of explosive loading, neither blasting nor non-blasting vibrations exceed selected thresholds based on structural damage.	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2

DEIS Section	Issue Category	Alternative 1 – No Action	Alternative 2 – Near West Proposed Action	Alternative 3 – Near West – Ultrathickened	Alternative 4 – Silver King	Alternative 5 – Peg Leg	Alternative 6 – Skunk Camp
	4-6. [DROPPED][5]						.
3.14.4	4-7. [REVISED][6] Qualitative assessment of number of impacted sites known/likely to have human remains.	If the GPO is not approved and the land exchange does not occur, there would be no effect.	At this time, no sites have been determined to contain human remains; this would be determined during data recovery activities, and a burial plan would be in place to properly handle any human remains identified.	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2
	4-8. [DROPPED][7]						
	Issue 5A: Public Health and Safety – Health Impacts						
	5A-1: [DROPPED][8]						
3.2.4	5A-2: [REVISED][9] Qualitative assessment of the public health risk from geologic hazards, including seismic activity.	If the GPO is not approved and the land exchange does not occur, there would be no effect.	Induced mine seismicity has been observed at other mines and is possible, but unlikely to be of sufficient magnitude to cause structural damage.	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2

[5] The original issue factor expected to be analyzed was: "Qualitative assessment of impacts to historic properties including visual impacts." Any historical sites are already incorporated into the analysis described by issue factor 4-3.

[6] The original issue factor expected to be analyzed was: "Quantitative assessment of number of impacted prehistoric sites known/likely to have human remains." The issue factor was modified to incorporate issue factor 4-8, and changed from a quantitative to a qualitative assessment.

[7] The original issue factor expected to be analyzed was: "Quantitative assessment of number of historic sites likely to have human remains." The issue factor was incorporated into issue factor 4-7.

[8] The original issue factor expected to be analyzed was: "Qualitative assessment of the public health risk from mine operations and facilities, including the potential for exposure to historically contaminated soil." The issue factor was generic and duplicative of more specific risks to human health analyzed by issue factors 5A-2, 5A-3, 5A-4, 5B-1, 5B-2, 5C-1, 5C-2, 5C-3, and 5C-4.

[9] This issue factor largely overlapped with issue factor 9A-3: "Qualitative assessment of the impact of the project to seismic activity." Issue factor 5A-2 has been modified to incorporate this aspect, and issue factor 9A-3 has been dropped.

DEIS Section	Issue Category	Alternative 1 – No Action	Alternative 2 – Near West Proposed Action	Alternative 3 – Near West – Ultrathickened	Alternative 4 – Silver King	Alternative 5 – Peg Leg	Alternative 6 – Skunk Camp
3.4.4	5A-3: Qualitative assessment of the public health risk from noise and vibrations.	If the GPO is not approved and the land exchange does not occur, there would be no effect.	Noise and vibration levels from mine construction and operation are expected to occasionally be perceptible to residents of the town of Superior and visitors to the immediate area of the East Plant Site, West Plant Site, filter plant and loadout facility, and this or other tailing storage facility location, particularly during construction phases, and from haul trucks during active operations, but mine-related noises and vibrations are not expected to represent either short- or long-term threats to public health and safety.	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2

DEIS Section	Issue Category	Alternative 1 – No Action	Alternative 2 – Near West Proposed Action	Alternative 3 – Near West – Ultrathickened	Alternative 4 – Silver King	Alternative 5 – Peg Leg	Alternative 6 – Skunk Camp
3.6.4	5A-4: Quantitative assessment of the ability to meet air quality standards for human health.	No mine activities other than ongoing dewatering would occur; it is expected that current air quality standards would be met.	Air quality impacts from construction and operation of the Resolution Mine are not expected at any time to exceed NAAQS criteria pollutant thresholds, including those for particulates, and are therefore not anticipated to represent a threat to public health. A supplemental health impact analysis was conducted to assess the potential for both cancer risk and non-carcinogenic chronic health effects from exposure to airborne NPAG tailings. The analysis determined that Alternative 2 does not exceed selected thresholds for health risk.	Same as Alternative 2	Same as Alternative 2. The health impact analysis for Alternative 4 considered exposure to both NPAG and PAG airborne tailings. The analysis determined that Alternative 4 does not exceed selected thresholds for health risk.	Same as Alternative 2	Same as Alternative 2

DEIS Section	Issue Category	Alternative 1 – No Action	Alternative 2 – Near West Proposed Action	Alternative 3 – Near West – Ultrathickened	Alternative 4 – Silver King	Alternative 5 – Peg Leg	Alternative 6 – Skunk Camp
	Issue 5B: Public Health and Safety – Safety Concerns Related to Tailings Impoundment						
	5B-1: [REVISED][10] Qualitative assessment of the risk of failure of tailings dam or concentrate/ tailings pipelines and potential impacts downstream in the event of a failure.	No risk of failure, as no tailings facility or pipelines would be built.	Risk of failure is minimized by required adherence to National Dam Safety Program and APP standards, and applicant-committed environmental protection measures. Alternative 2 embankment is less resilient than Alternatives 5 and 6 due to: modified-centerline construction, long embankment (10 miles), freestanding structure	Alternative 3 embankment is less resilient than Alternatives 5 and 6 due to: modified-centerline construction, long embankment (10 miles), freestanding structure. Alternative 3 is more resilient than Alternative 2 due to ultrathickening.	Alternative 4 represents the least risk of all alternatives. Failure of filtered tailings would result in localized slump or landslide, not a long downstream runout.	Alternative 5 embankment is more resilient than Alternatives 2 and 3 due to: centerline construction, shorter embankment (7 miles). Double embankment for PAG using a downstream dam, and use of multiple PAG cells, reduces risk of PAG release.	Alternative 6 embankment is more resilient than Alternatives 2, 3, and 5 due to: centerline construction, shortest embankment (3 miles), cross-valley construction with tie-in to solid rock on each side. Double embankment for PAG using a downstream embankment, and use of multiple PAG cells, reduces risk of PAG release.
	5B-2: Quantitative assessment of the seismic stability of the tailings impoundment.	No tailings facility would be built.	The design earthquake meets the most stringent of all standards (Maximum Credible Earthquake), and static factor of safety (1.5) and seismic factor of safety (1.2) meet the most stringent of all standards.	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2

[10] The original issue factor only referenced the tailings storage facility, and has been modified to include both concentrate and tailings pipelines.

DEIS Section	Issue Category	Alternative 1 – No Action	Alternative 2 – Near West Proposed Action	Alternative 3 – Near West – Ultrathickened	Alternative 4 – Silver King	Alternative 5 – Peg Leg	Alternative 6 – Skunk Camp
	Issue 5C: Public Health and Safety – Transportation-Related and General Safety Risks						
3.5.6.1	5C-1: Quantitative assessment of the potential change in traffic accidents.	No change from current traffic volumes and patterns.	Under Alternative 2 increased traffic associated with mine worker commuting and truck traffic to and from the mine is expected to result in increased traffic congestion and increased risk of traffic accidents.	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2
	5C-2: [DROPPED][11]						

[11] The original issue factor expected to be analyzed was: “Quantitative assessment of the trip count per day for all hazardous materials and qualitative assessment of potential effectsl.” The issue factor was combined with issue factor 5C-3.

DEIS Section	Issue Category	Alternative 1 – No Action	Alternative 2 – Near West Proposed Action	Alternative 3 – Near West – Ultrathickened	Alternative 4 – Silver King	Alternative 5 – Peg Leg	Alternative 6 – Skunk Camp
3.10.3.4	5C-3: Qualitative assessment of the risks to public health from potential accidents or spills during the transport of hazardous materials.	No impacts anticipated.	Potential releases of hazardous materials during transportation could occur, but the fate and transport of those hazardous materials depend entirely on where the release occurs and the quantity of the release. In general, there would be direct impacts on plants and wildlife in the immediate vicinity, direct impacts on soil in the immediate vicinity, and possible migration into surface water either directly or via stormwater runoff from contaminated areas. Queen Creek and tributary washes (like Silver King Wash) are the locations most likely to be affected in the event of a transportation release.	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2

DEIS Section	Issue Category	Alternative 1 – No Action	Alternative 2 – Near West Proposed Action	Alternative 3 – Near West – Ultrathickened	Alternative 4 – Silver King	Alternative 5 – Peg Leg	Alternative 6 – Skunk Camp
3.5.6.1, 3.10.3.4, and 3.13.4.2	5C-4: Qualitative assessment of the impacts to local emergency response to accidents or spills on public roadways.	No change from current conditions.	Under Alternative 2, increased traffic associated with mine worker commuting and truck traffic to and from the mine is expected to result in increased risk of traffic accidents. There may also be an increased risk of hazardous materials simply due to an increased presence of hazardous materials at mine facilities and the regular transport of these materials to and from these facilities. The Town of Superior anticipates that its costs of providing services related to public safety would increase by about 50%; Resolution Copper has entered into an agreement with the Town of Superior to provide $1.65 million to support emergency response services by the Town over the period from 2016 to 2021.	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2
	Issue 5D: Public Health and Safety – Risks Related to Subsidence						
	5D-1: [DROPPED][12]						

[12] The original issue factor expected to be analyzed was: "Qualitative assessment of the public health risk from geological hazards." This duplicates issue factor 5A-2.

DEIS Section	Issue Category	Alternative 1 – No Action	Alternative 2 – Near West Proposed Action	Alternative 3 – Near West – Ultrathickened	Alternative 4 – Silver King	Alternative 5 – Peg Leg	Alternative 6 – Skunk Camp
3.10.2	5D-2: Qualitative assessment of increased fire risk due to mine operations and subsidence	No change from current conditions.	While increased risks of fire ignition from mine activities (i.e., blasting, construction, increased traffic) cannot be entirely prevented, risks are expected to be substantially mitigated through adherence to a fire plan that requires mine employees to be trained for initial fire suppression and to have fire tools and water readily available.	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2
	Issue 6A: Water Resources – Groundwater Availability						
3.7.1.4	6A-1. Direction and magnitude of change in aquifer water level, compared with background conditions.	Drawdown from mine dewatering anticipated under the no action alternative up to >50 feet at six springs. No effects anticipated to perennial streams.	Additional drawdown caused by block caving anticipated at two additional springs; one spring (DC-6.6W) feeds perennial flow in Devil’s Canyon, contributing up to 5% of flow.	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2

DEIS Section	Issue Category	Alternative 1 – No Action	Alternative 2 – Near West Proposed Action	Alternative 3 – Near West – Ultrathickened	Alternative 4 – Silver King	Alternative 5 – Peg Leg	Alternative 6 – Skunk Camp
3.7.1.4	6A-2. Geographic extent in which water resources may be impacted.	Geographic area impacted by groundwater drawdown under the no action alternative shown in figure 3.7.1-8.	Geographic area impacted by groundwater drawdown caused by mine dewatering shown in figure 3.7.1-3; geographic area impacted by groundwater drawdown caused by the Desert Wellfield shown in figure 3.7.1-2.	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2
3.7.1.4	6A-3. Duration of the effect (in years).	Takes ~150–200 years to see maximum drawdown from mine dewatering; recovery of water levels would continue longer. No drawdown would occur at Desert Wellfield.	Takes ~500–900 years to see maximum drawdown from mine dewatering at some GDE locations; recovery of water levels would continue longer. Drawdown at Desert Wellfield recovers within ~130 years after closure.	Same as Alternative 2	Same as Alternative 2 for mine dewatering Drawdown at Desert Wellfield recovers within ~20 years after closure	Same as Alternative 2	Same as Alternative 2
3.7.1.4	6A-4. Comparison of mine water needs and water balance with overall basin water balance, both total volume (acre-feet) and annual rate (acre-feet per year).	No water would be pumped from Desert Wellfield. Mine dewatering pumping would continue indefinitely.	Desert Wellfield pumping over life of mine = 590,000 acre-feet 87,000 acre-feet pumped over life of mine for dewatering	Desert Wellfield pumping over life of mine = 490,000 acre-feet 87,000 acre-feet pumped over life of mine for dewatering	Desert Wellfield pumping over life of mine = 180,000 acre-feet 87,000 acre-feet pumped over life of mine for dewatering	Desert Wellfield pumping over life of mine = 540,000 acre-feet 87,000 acre-feet pumped over life of mine for dewatering	Desert Wellfield pumping over life of mine = 540,000 acre-feet 87,000 acre-feet pumped over life of mine for dewatering

DEIS Section	Issue Category	Alternative 1 – No Action	Alternative 2 – Near West Proposed Action	Alternative 3 – Near West – Ultrathickened	Alternative 4 – Silver King	Alternative 5 – Peg Leg	Alternative 6 – Skunk Camp
3.7.1.4	6A-5. REVISED[13] Assessment of impact to general groundwater supply areas (feet of water-level decrease).	No impacts anticipated.	For wells connected to regional aquifers, drawdown from mine dewatering up to 30 feet anticipated in Top-of-the-World and Superior. Wells in shallow alluvium or fractures are unlikely to be impacted. Maximum drawdown impacts from Desert Wellfield anticipated to be 40–50 feet at NMIDD, 110–140 feet near wellfield.	Same as Alternative 2	Same as Alternative 2 for mine dewatering Maximum drawdown impacts from Desert Wellfield anticipated to be less than 20 feet at NMIDD, 30–35 feet near wellfield	Same as Alternative 2	Same as Alternative 2
3.7.1.4	6A-6. Potential for subsidence to occur as a result of groundwater withdrawal.	No impacts anticipated.	Drawdown associated with the Desert Wellfield would contribute to lowering of groundwater levels in the East Salt River valley basin, including near two known areas of known ground subsidence. There is the potential for Desert Wellfield pumping to contribute to regional subsidence.	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2

[13] The original issue factor expected to be analyzed was: “Number of known private and public water supply wells within the geographic extent of the water-level impact and assessment of impact to these water supplies (feet of water-level decrease).” The Forest Service determined that analyzing impacts to individual wells was not feasible (see section 3.7.1). Impacts on representative wells were assessed instead.

DEIS Section	Issue Category	Alternative 1 – No Action	Alternative 2 – Near West Proposed Action	Alternative 3 – Near West – Ultrathickened	Alternative 4 – Silver King	Alternative 5 – Peg Leg	Alternative 6 – Skunk Camp
	Issue 6B: Water Resources – Groundwater Quality						
3.7.2.4, Risk of Seepage Impacting Groundwater or Surface Water Quality (sections for each alternative)	6B-1. [REVISED][14] Quantitative assessment of anticipated groundwater quality changes, compared for context to Arizona water quality standards	No tailings seepage would occur; no changes in groundwater quality beyond existing conditions would be anticipated.	Concentrations are not anticipated to be above standards in aquifers downgradient of tailings facility. Selenium concentrations are anticipated to be above surface water standards at Whitlow Ranch Dam. Most concentrations are anticipated to increase from baseline conditions; sulfate concentrations are anticipated to be above secondary standards.	Concentrations are not anticipated to be above standards in aquifers or surface waters downgradient of tailings facility. Selenium and cadmium concentrations are anticipated to increase from baseline conditions.	Concentrations are not anticipated to be above standards in aquifers downgradient of tailings facility. Selenium concentrations are anticipated to be above surface water standards at Whitlow Ranch Dam. Most concentrations are anticipated to increase from baseline conditions; sulfate concentrations are anticipated to be above secondary standards.	Concentrations are not anticipated to be above standards in aquifers or surface waters downgradient of tailings facility. Most concentrations are anticipated to increase from baseline conditions; sulfate concentrations are anticipated to be substantially above secondary standards.	Concentrations are not anticipated to be above standards in aquifers or surface waters downgradient of tailings facility. Most concentrations are anticipated to increase from baseline conditions; sulfate concentrations are anticipated to be above secondary standards.
3.7.2.4, Risk of Seepage Impacting Groundwater or Surface Water Quality (sections for each alternative)	6B-2. [REVISED][15] Qualitative assessment of seepage control techniques	No seepage control needed.	Modeled seepage control efficiency of 99%. Risk of not meeting desired efficiency is high.	Modeled seepage control efficiency of 99.5%. Risk of not meeting desired efficiency is high.	Estimated seepage control efficiency of 90%. Risk of not meeting desired efficiency is moderate.	Modeled seepage control efficiency of 84%. Risk of not meeting desired efficiency is moderate.	Modeled seepage control efficiency of 90%. Risk of not meeting desired efficiency is moderate.

[14] The original issue factor expected to be analyzed was: "Quantitative assessment of the ability to meet Arizona Aquifer Water Quality Standards at points of compliance designated in the aquifer protection permit." The authority to determine the ability to meet water quality standards lies with the State of Arizona. The Forest Service disclosure focuses on anticipated impacts to groundwater and surface water quality; comparison to water quality standards is presented for context, but is not a regulatory determination.

[15] The original issue factor expected to be analyzed was: "Qualitative assessment of the ability to demonstrate best available demonstrated control technology." Assessment of the ability to meet best available demonstrated control technology is under the authority of the State of Arizona. The Forest Service has instead assessed the expected seepage control techniques and the ability of the project to control seepage to the point that water quality standards are likely to be met.

DEIS Section	Issue Category	Alternative 1 – No Action	Alternative 2 – Near West Proposed Action	Alternative 3 – Near West – Ultrathickened	Alternative 4 – Silver King	Alternative 5 – Peg Leg	Alternative 6 – Skunk Camp
3.7.2.4, Risk of Seepage Impacting Groundwater or Surface Water Quality (sections for each alternative)	6B-3. Quantitative assessment of the estimated changes in groundwater quality in situ in the area of block caving, including the estimated fate and transport.	No block-caving would occur; no changes in groundwater quality beyond existing conditions would be anticipated.	Thallium concentrations modeled to be above standards at end of operations. Substantial uncertainty with effect of oxidation over time, which would further degrade water quality.	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2
	6B-4. [DROPPED][16]						

[16] The original issue factor expected to be analyzed was: "Quantitative assessment of the estimated changes in groundwater quality as a result of seepage from tailings area, including the estimated fate and transport." This duplicates issue factor 6B-1.

DEIS Section	Issue Category	Alternative 1 – No Action	Alternative 2 – Near West Proposed Action	Alternative 3 – Near West – Ultrathickened	Alternative 4 – Silver King	Alternative 5 – Peg Leg	Alternative 6 – Skunk Camp
3.10.3.4	6B-5. Qualitative assessment of the potential for spills or inadvertent release of contaminants to groundwater.	No impacts anticipated.	The process water temporary storage ponds are double-lined with leak detection. Infiltration is unlikely to occur under normal operating conditions, and leak detection is incorporated into the process water portion of the pond. If an unplanned spill were to occur, releases underground or at the East Plant Site would be unlikely to migrate due to the hydraulic sink created by dewatering; releases at the tailings storage facility would be likely captured by seepage controls. The primary concern would be spills within the West Plant Site that could likely migrate toward Queen Creek and eventually downstream. Emergency response and material handling plans minimize the risk of release and provide for rapid emergency cleanup.	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2

DEIS Section	Issue Category	Alternative 1 – No Action	Alternative 2 – Near West Proposed Action	Alternative 3 – Near West – Ultrathickened	Alternative 4 – Silver King	Alternative 5 – Peg Leg	Alternative 6 – Skunk Camp
	Issue 6C: Water Resources – Surface Water Availability						
3.7.1.5	6C-1/6C-2. [REVISED][17] Qualitative assessment of the potential lowering of the water table or reduced groundwater flow to Queen Creek, Devil's Canyon, Arnett Creek, Mineral Creek, or other perennial waters that results in permanent changes in flow patterns and that may affect current designated uses	No impacts anticipated.	No direct impacts to perennial flow in Queen Creek, Devil's Canyon, Arnett Creek, or Mineral Creek are anticipated from groundwater drawdown. However, additional drawdown is anticipated to impact spring DC-6.6W which feeds perennial flow in Devil's Canyon, contributing up to 5% of flow.	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2
3.16.4	6C-3. [REVISED][18] Quantitative assessment of the number of water sources that would be lost to direct disturbance or dewatering	No impacts anticipated.	25 water sources anticipated to be impacted	Same as Alternative 2	24 water sources anticipated to be impacted	14 water sources anticipated to be impacted	21 water sources anticipated to be impacted

[17] Originally two issue factors were expected to be analyzed: "6C-1. Quantitative assessment of the number of stream miles changed from intermittent/perennial flow status to ephemeral flow status as a result of the project;" and "6C-2. Quantitative assessment of the potential lowering of the water table or reduced groundwater flow to Queen Creek, Devil's Canyon, Arnett Creek, Mineral Creek, or other perennial waters that results in permanent changes in flow patterns and that may affect current designated uses." Given the limitations of the groundwater model to predict surface water impacts, these factors were combined and modified.

[18] The original issue factor expected to be analyzed was: "Quantitative assessment of the number of stock watering tanks that would be lost to direct disturbance or reductions in surface flow." Most changes to water sources for both stock and wildlife are from loss of springs, not stock tanks. This issue factor was changed to reflect all water sources lost due to direct or indirect disturbance.

DEIS Section	Issue Category	Alternative 1 – No Action	Alternative 2 – Near West Proposed Action	Alternative 3 – Near West – Ultrathickened	Alternative 4 – Silver King	Alternative 5 – Peg Leg	Alternative 6 – Skunk Camp
3.7.3.4	6C-4. Quantitative assessment of the change in volume, frequency, and magnitude of runoff from the project area.	No impacts anticipated.	Reduction in annual average runoff of 3.5% at mouth of Devil's Canyon due to subsidence crater. Reduction in annual average runoff of 6.5% in Queen Creek at Whitlow Ranch Dam.	Same as Alternative 2	Reduction in annual average runoff of 3.5% at mouth of Devil's Canyon due to subsidence crater. Reduction in annual average runoff of 19.9% in Queen Creek at Boyce Thompson Arboretum, and 8.9% at Whitlow Ranch Dam.	Reduction in annual average runoff of 3.5% at mouth of Devil's Canyon due to subsidence crater. Reduction in annual average runoff of 21.3% at mouth of Donnelly Wash, and 0.2% in Gila River.	Reduction in annual average runoff of 3.5% at mouth of Devil's Canyon due to subsidence crater. Reduction in annual average runoff of 12.9% at mouth of Dripping Spring Wash, and 0.5% in Gila River.
	Issue 6D: Water Resources – Surface Water Quality						
3.7.2.4, Potential Surface Water Quality Impacts from Stormwater Runoff	6D-1. [REVISED][19] Quantitative assessment of anticipated surface water quality changes from runoff, compared for context to Arizona water quality standards.	No impacts anticipated.	No impacts anticipated due to operational stormwater controls and post-closure reclamation cover; runoff is not allowed to be released after operations until appropriate water quality standards are met.	Same as Alternative 2	Same as Alternative 2. Some potential for Alternative 4 to require treatment of collected PAG runoff prior to recycling.	Same as Alternative 2	Same as Alternative 2
3.7.3.4	6D-2. Qualitative assessment of the change in geomorphology and characteristics of downstream channels.	No impacts anticipated.	No impacts anticipated.	No impacts anticipated.	No impacts anticipated.	No impacts anticipated.	No impacts anticipated.
	6D-3. [DROPPED][20]						

[19] The original issue factor expected to be analyzed was: "Quantitative assessment of the ability to meet Arizona Surface Water Quality Standards for the appropriate designated uses." The authority to determine the ability to meet water quality standards lies with the State of Arizona. The Forest Service disclosure focuses on anticipated impacts to groundwater and surface water quality; comparison to water quality standards is presented for context, but is not a regulatory determination. Note that surface water quality impacts potentially caused by tailings seepage are assessed under issue factor 6B-1.

[20] The original issue factor expected to be analyzed was: "Quantitative assessment of the acres and locations that may be affected by surface water quality impacts and the duration (in years) of those impacts." This duplicates issue factor 6D-1.

DEIS Section	Issue Category	Alternative 1 – No Action	Alternative 2 – Near West Proposed Action	Alternative 3 – Near West – Ultrathickened	Alternative 4 – Silver King	Alternative 5 – Peg Leg	Alternative 6 – Skunk Camp
3.7.3.4	6D-4. Quantitative assessment of the acres of potentially jurisdictional waters of the U.S. impacted.	No impacts anticipated.	No jurisdictional waters are located above Whitlow Ranch Dam (as determined by U.S. Army Corps of Engineers)	No jurisdictional waters are located above Whitlow Ranch Dam (as determined by U.S. Army Corps of Engineers)	No jurisdictional waters are located above Whitlow Ranch Dam (as determined by U.S. Army Corps of Engineers)	Preliminary impacts estimated as 182.5 acres; delineation not yet reviewed by U.S. Army Corps of Engineers	Preliminary impacts estimated as 120.0 acres; delineation not yet reviewed by U.S. Army Corps of Engineers
	Issue 6E: Water Resources – Seeps, Springs, Riparian Areas, and Groundwater-Dependent Ecosystems						
3.3.4	6E-1. Acres of riparian areas disturbed, by vegetation classification.	No impacts anticipated.	Riparian = 28 acres Xeroriparian = 135 acres	Same as Alternative 2	Riparian = 44 acres Xeroriparian = 184 acres	Riparian = 35 acres Xeroriparian = 171–195 acres (varies by pipeline route)	Riparian = 90–92 acres (varies by pipeline route) Xeroriparian = 766–813 acres (varies by pipeline route)

DEIS Section	Issue Category	Alternative 1 – No Action	Alternative 2 – Near West Proposed Action	Alternative 3 – Near West – Ultrathickened	Alternative 4 – Silver King	Alternative 5 – Peg Leg	Alternative 6 – Skunk Camp
3.7.1.4	6E-2. [REVISED][21] Number of GDEs degraded or lost.	Under the no action alternative Resolution Copper would continue dewatering activities at the East Plant Site. It is anticipated under the no action alternative that as many as six sacred springs could be adversely affected by drawdown due to continued mine dewatering.	Two additional springs would be impacted by dewatering once block-caving begins. Three additional springs would be buried beneath the tailings impoundment, and two additional springs would be within the subsidence area. In addition, two GDEs associated with Queen Creek and one GDE associated with Devil's Canyon would experience some reduction in surface flow due to runoff captured by the subsidence area or tailings facility. A total of 16 GDEs would be impacted under Alternative 2.	Same as Alternative 2	Same as Alternative 2 for mine dewatering, subsidence, and changes to surface flow (13 GDEs). Two additional springs would be buried beneath the tailings impoundment, but one of these would already be impacted by drawdown. A total of 14 GDEs would be impacted under Alternative 4.	Same as Alternative 2 for mine dewatering, subsidence, and changes to surface flow (13 GDEs). No GDEs have been identified that would be lost due to tailings facility, but one additional GDE (the Gila River) would be impacted by reductions in surface flow due to the tailings facility. A total of 14 GDEs would be impacted under Alternative 5.	Same as Alternative 2 for mine dewatering, subsidence, and subsidence changes to surface flow (13 GDEs). No GDEs have been identified that would be lost due to tailings facility, but one additional GDE (the Gila River) would be impacted by reductions in surface flow due to the tailings facility. A total of 14 GDEs would be impacted under Alternative 6.

[21] The original issue factor expected to be analyzed was: "Number of seeps and springs degraded or lost." Many springs on the landscape are not perennial sources or water or support riparian vegetation. While the impacts to livestock/grazing focused on any named springs of water sources, regardless of their connection to groundwater (see factor 6C-3), the focus of the groundwater analysis was on specific areas with perennial flow and riparian vegetation that were determined to be groundwater-dependent ecosystems. This factor was changed to reflect only groundwater-dependent ecosystems.

DEIS Section	Issue Category	Alternative 1 – No Action	Alternative 2 – Near West Proposed Action	Alternative 3 – Near West – Ultrathickened	Alternative 4 – Silver King	Alternative 5 – Peg Leg	Alternative 6 – Skunk Camp
3.7.1.4; 3.7.3.4	6E-3. Change in the function of riparian areas.	Riparian function of six springs anticipated to be lost due to mine dewatering; mitigation measures would not be in place to replace flow to these springs.	A total of 13 springs anticipated to be impacted due to mine dewatering, subsidence, and direct disturbance. Mitigation measures would be effective at replacing water such that there would be no net loss of riparian ecosystems or aquatic habitat on the landscape, although ecosystems would change to adapt to new water sources. Devil's Canyon would receive less runoff and less inflow from one spring anticipated to be impacted (DC-6.6W), anticipated at 5 to 10%. Queen Creek would receive less runoff, ranging from 13% to 19% above Boyce Thompson Arboretum. Losses could contribute to a reduction in the extent and health of riparian vegetation. Complete drying of the downstream habitat, loss of dominant riparian vegetation, or loss of standing pools would be unlikely.	Same as Alternative 2	Same as Alternative 2, except 11 springs anticipated to be impacted. Greater flow losses are seen in Queen Creek, which could result in larger impacts than Alternative 2, but similar in nature.	Same as Alternative 2, except 10 springs anticipated to be impacted. Gila River would receive less runoff, but watershed losses (as a percentage change in perennial flow) are relatively low for Alternative 5 (0.2% at Donnelly Wash), largely due to the large watershed and flow of the Gila River.	Same as Alternative 2, except 10 springs anticipated to impacted. Gila River would receive less runoff, but watershed losses (as a percentage change in perennial flow) are relatively low for Alternative 6 (0.3% at Donnelly Wash), largely due to the large watershed and flow of the Gila River.

DEIS Section	Issue Category	Alternative 1 – No Action	Alternative 2 – Near West Proposed Action	Alternative 3 – Near West – Ultrathickened	Alternative 4 – Silver King	Alternative 5 – Peg Leg	Alternative 6 – Skunk Camp
3.7.1.4; 3.7.3.4 (*Continued*)	6E-3. Change in the function of riparian areas. (*Continued*)		There are no anticipated impacts to riparian areas along Telegraph Canyon, Arnett Creek, or Mineral Creek.				
	6E-4. [DROPPED][22]						
	Issue 6F: Water Resources – Floodplains						
3.7.3.4	6F-1. Quantitative assessment of the acreage of 100-year floodplains impacted (acreage)	No impacts anticipated.	8.5 acres (based on available floodplain maps)	Same as Alternative 2	Same as Alternative 2	167–171 acres of floodplain (varies by pipeline route; based on available floodplain maps)	794 acres (based on available floodplain maps)
	6F-2. [DROPPED][23]						

[22] The original issue factor expected to be analyzed was: "Ability to meet legal and regulatory requirements for riparian areas." This was originally considered in the event that some riparian areas had special designations under Arizona regulation, such as designated Outstanding Arizona Waters. No riparian areas were identified with special designations.

[23] The original issue factor expected to be analyzed was: "Qualitative assessment of the impact of floodplain changes to upstream or downstream users or residents." Ultimately, the mapping coverage for floodplains is inconsistent and impacts to downstream users would require more specific designs for how washes would be filled. For instance, while pipelines might cross mapped floodplains, if they are buried, there would be no anticipated impacts to downstream users or residents.

DEIS Section	Issue Category	Alternative 1 – No Action	Alternative 2 – Near West Proposed Action	Alternative 3 – Near West – Ultrathickened	Alternative 4 – Silver King	Alternative 5 – Peg Leg	Alternative 6 – Skunk Camp
	Water Resources – Additional Issue Factors Analyzed						
3.7.3.4	Acres of wetland impacted, based on National Wetland Inventory	No impacts anticipated.	92.5 acres associated with ephemeral washes 5.1 acres associated with stock tanks 1 acre associated with Benson Spring and in subsidence area	Same as Alternative 2	86.2 acres associated with ephemeral washes 4.1 acres associated with stock tanks 0.2 acre in subsidence area	(Varies by pipeline alternative) 200.9–219.6 acres associated with ephemeral washes 8.6–8.8 acres associated with stock tanks 0.2 acre in subsidence area Includes crossings of Gila River, which may not require disturbance	(Varies by pipeline alternative) 229.6–232.9 acres associated with ephemeral washes 25.4–28.2 acres associated with Queen Creek, Devil's Canyon, Mineral Creek 11.9–12.7 acres associated with stock tanks 0.2 acre in subsidence area

DEIS Section	Issue Category	Alternative 1 – No Action	Alternative 2 – Near West Proposed Action	Alternative 3 – Near West – Ultrathickened	Alternative 4 – Silver King	Alternative 5 – Peg Leg	Alternative 6 – Skunk Camp
	Issue 7A: Biological Resources – Adverse Effects of Dewatering at the East Plant Site or Pumping at the West Plant Site						
3.7.1.4; 3.8.4	7A-1. Qualitative assessment of effects on riparian habitat and species due to changes in flow to Queen Creek, Devil's Canyon, Arnett Creek, Mineral Creek, or other perennial or intermittent waters. [This assessment will be based on the results of the Issue 6 Analysis Factors]	Riparian function of six springs anticipated to be lost due to mine dewatering; mitigation measures would not be in place to replace flow to these springs.	Impacts on fish species include mortality from loss or modification of habitat due to changes in surface water levels or flows, including changes due to changes in groundwater elevation and contribution to surface flows. Would occur for all action alternatives and would have the greatest potential to impact fish species along areas of Devil's Canyon and Queen Creek that currently have surface flows. Impacts are to non-native fish populations (no native fish known to occur) in these locations.	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2

DEIS Section	Issue Category	Alternative 1 – No Action	Alternative 2 – Near West Proposed Action	Alternative 3 – Near West – Ultrathickened	Alternative 4 – Silver King	Alternative 5 – Peg Leg	Alternative 6 – Skunk Camp
3.7.1.4; 3.8.4 (*Continued*)	7A-1. Qualitative assessment of effects on riparian habitat and species due to changes in flow to Queen Creek, Devil's Canyon, Arnett Creek, Mineral Creek, or other perennial or intermittent waters. [This assessment will be based on the results of the Issue 6 Analysis Factors] (*Continued*)		No impacts are anticipated in Mineral Creek to longfin dace or Gila chub. Riparian changes impacting amphibious or invertebrate species could occur along areas of Devil's Canyon and Queen Creek that currently have perennial surface flows that would be reduced by changes in runoff. Most water sources potentially impacted by the project would be replaced.				
	Issue 7B: Biological Resources – Loss or Harassment of Individual Plants and Animals						
3.8.4	7B-1. Quantitative assessment of acres of suitable habitat disturbed for each special status species, including impacts to designated and proposed critical habitat.	No changes from current conditions are anticipated.	Please see DEIS table 3.8.4-2; this acreage information is too extensive to be summarized here.	Please see DEIS table 3.8.4-2; this acreage information is too extensive to be summarized here.	Please see DEIS table 3.8.4-2; this acreage information is too extensive to be summarized here.	Please see DEIS table 3.8.4-2; this acreage information is too extensive to be summarized here.	Please see DEIS table 3.8.4-2; this acreage information is too extensive to be summarized here.

DEIS Section	Issue Category	Alternative 1 – No Action	Alternative 2 – Near West Proposed Action	Alternative 3 – Near West – Ultrathickened	Alternative 4 – Silver King	Alternative 5 – Peg Leg	Alternative 6 – Skunk Camp
3.8.4	7B-2. Qualitative assessment of the potential to affect the population viability of any species and qualitative assessment of mortality of various animal species resulting from the increased volume of traffic related to mine operations.	No changes from current conditions are anticipated.	Under this or any action alternative there would be a high probability of mortality and/or injury of wildlife individuals from collisions with mine construction and employee vehicles, as well as the potential mortality of burrowing animals in areas where grading would occur. Some species could see impacts on local populations in the action area, but no regional population-level impacts are likely.	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2

DEIS Section	Issue Category	Alternative 1 – No Action	Alternative 2 – Near West Proposed Action	Alternative 3 – Near West – Ultrathickened	Alternative 4 – Silver King	Alternative 5 – Peg Leg	Alternative 6 – Skunk Camp
3.8.4	7B-3. Qualitative assessment of the potential for disturbance to create conditions conducive for invasive species.	No changes from current conditions are anticipated.	Ground disturbance, particularly during project construction, would be likely to increase the potential for the introduction and colonization of disturbed areas by noxious and invasive plant species. These potential vegetation changes may decrease suitability of disturbed areas to support breeding, rearing, foraging, and dispersal activities of wildlife and special status species, and may also lead to a shift over time to more wildfire-adapted vegetation that favors noxious or invasive exotic species over native species.	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2

DEIS Section	Issue Category	Alternative 1 – No Action	Alternative 2 – Near West Proposed Action	Alternative 3 – Near West – Ultrathickened	Alternative 4 – Silver King	Alternative 5 – Peg Leg	Alternative 6 – Skunk Camp
3.8.4	7B-4. Qualitative assessment of effects on wildlife behavior from noise, vibrations, and light.	No changes from current conditions are anticipated.	Noise, vibrations, and light from mine construction and operations may change habitat use patterns for some species. Some individuals would be likely to move away from the sources of disturbance to adjacent or nearby habitats. Project-related noise, vibration, and light may also lead to increased stress on individuals and alteration of feeding, breeding, and other behaviors. Some species could see impacts on local populations in the action area, but no regional population-level impacts are likely.	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2

DEIS Section	Issue Category	Alternative 1 – No Action	Alternative 2 – Near West Proposed Action	Alternative 3 – Near West – Ultrathickened	Alternative 4 – Silver King	Alternative 5 – Peg Leg	Alternative 6 – Skunk Camp
	Issue 7C: Biological Resources – Habitat Fragmentation and Loss						
3.8.4	7C-1. Qualitative assessment of the change in movement corridors and connectivity between wildlife habitats.	No changes from current conditions are anticipated.	Potential impacts to wildlife movement corridors from all action alternatives would include the loss and fragmentation of movement and dispersal habitats from the subsidence area and from the tailings storage facility. Ground-clearing and consequent fragmentation of habitat blocks for other mine-related facilities would also inhibit wildlife movement. Obstacles to wildlife movement would also be created by pipeline corridors and other linear facilities, though restrictions to movement across linear features may be eased through mitigation.	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2

DEIS Section	Issue Category	Alternative 1 – No Action	Alternative 2 – Near West Proposed Action	Alternative 3 – Near West – Ultrathickened	Alternative 4 – Silver King	Alternative 5 – Peg Leg	Alternative 6 – Skunk Camp
3.8.4	7C-2. [REVISED][24] Quantitative assessment of acres by type of terrestrial habitat lost, altered, or indirectly impacted.	No changes from current conditions are anticipated.	Projected losses of habitat acres under each action alternative are itemized in table 3.8.4-3; this information is too extensive to be summarized here.	Projected losses of habitat acres under each action alternative are itemized in table 3.8.4-3; this information is too extensive to be summarized here.	Projected losses of habitat acres under each action alternative are itemized in table 3.8.4-3; this information is too extensive to be summarized here.	Projected losses of habitat acres under each action alternative are itemized in table 3.8.4-3; this information is too extensive to be summarized here.	Projected losses of habitat acres under each action alternative are itemized in table 3.8.4-3; this information is too extensive to be summarized here.

[24] The original issue factor expected to be analyzed was: “Quantitative assessment of acres by type of terrestrial and aquatic habitat lost, altered, or indirectly impacted.” Aquatic habitat was removed from this issue factor because it is duplicated by issue factor 7A-1.

DEIS Section	Issue Category	Alternative 1 – No Action	Alternative 2 – Near West Proposed Action	Alternative 3 – Near West – Ultrathickened	Alternative 4 – Silver King	Alternative 5 – Peg Leg	Alternative 6 – Skunk Camp
3.8.3.2; 3.8.5; 3.7.1.4	7C-3. [REVISED][25] Qualitative assessment of impacts to surface water that support wildlife and plants such as stock tanks, seeps, and springs.	Six springs (not designated as wildlife waters) are anticipated to be lost due to mine dewatering; mitigation measures would not be in place to replace flow to these springs.	Of the 15 wildlife waters (waters built or improved such as stock tanks and wildlife guzzlers) within 5 miles of the project footprint, three would occur within the project facility area under this or other action alternatives. Benson Spring would be permanently lost beneath the tailings storage facility for Alternative 2. Mitigation would maintain or replace access to wildlife waters. An additional 12 springs not designated as wildlife waters are anticipated to be lost due to mine dewatering; mitigation would replace these waters as well.	Same as Alternative 2	Wildlife water Silver King Spring would be within the footprint of the tailings storage facility for Alternative 4 and would be permanently buried. Mitigation would maintain or replace access to wildlife waters. An additional 11 springs not designated as wildlife waters are anticipated to be lost due to mine dewatering; mitigation would replace these waters as well.	Wildlife water Mineral Mountain spring would be within the west pipeline route under this alternative. Mitigation would maintain or replace access to wildlife waters. An additional 10 springs not designated as wildlife waters are anticipated to be lost due to mine dewatering; mitigation would replace these waters as well.	No wildlife waters would be impacted under Alternative 6. Ten springs not designated as wildlife waters are anticipated to be lost due to mine dewatering; mitigation would replace these waters.
	7C-4. [DROPPED][26]						

[25] The original issue factor expected to be analyzed was: "Qualitative assessment of impacts to aquatic habitats and surface water that support wildlife and plants such as stock tanks, seeps, and springs." Aquatic habitat was removed from this issue factor because it is duplicated by issue factor 7A-1. This issue factor focuses instead on wildlife waters identified by the Arizona Game and Fish Department and springs.

[26] The original issue factor expected to be analyzed was: "Qualitative assessment of how changes in the function of riparian areas could impact wildlife habitat." This duplicates issue factor 7A-1.

DEIS Section	Issue Category	Alternative 1 – No Action	Alternative 2 – Near West Proposed Action	Alternative 3 – Near West – Ultrathickened	Alternative 4 – Silver King	Alternative 5 – Peg Leg	Alternative 6 – Skunk Camp
	Issue 8: Impacts to Air Quality						
3.6.2.2; 3.6.4.2	8-1. Quantitative estimate of particulate emissions (particulate matter less than or equal to 2.5 microns in diameter (PM2.5) and particulate matter less than or equal to 10 microns in diameter (PM10)), compared with background (pounds per hour [for 24-hour impacts] and tons per year [tons/year]) and expected seasonal dust patterns and impact area	No impacts anticipated.	The PM10 emissions are estimated as 328.9 tons per year. Maximum emission concentration is modeled as 26 $\mu g/m^3$ (24-hour) and 7 $\mu g/m^3$ (annual), compared to background concentrations of 71 $\mu g/m^3$ and 17 $\mu g/m^3$, respectively. The PM2.5 emissions are estimated as 77.8 tons per year. Maximum emission concentration is modeled as 11 $\mu g/m^3$ (24-hour) and 2 $\mu g/m^3$ (annual), compared to background concentrations of 6 $\mu g/m^3$ and 4 $\mu g/m^3$, respectively. Impact area does not extend beyond fence line.	Same as Alternative 2	Similar to Alternative 2	Similar to Alternative 2	Similar to Alternative 2

DEIS Section	Issue Category	Alternative 1 – No Action	Alternative 2 – Near West Proposed Action	Alternative 3 – Near West – Ultrathickened	Alternative 4 – Silver King	Alternative 5 – Peg Leg	Alternative 6 – Skunk Camp
3.6.2.2	8-2. Volatile organic compound (VOC) and hazardous air pollutant (HAP) emissions and emission rates (tons/year)	No impacts anticipated.	The estimated potential HAP emissions from the project (0.17 tons per year) are less than the major source thresholds (10 tons per year of any one HAP or 25 tons per year of all HAPs) The estimated VOC emissions from the project are 102.7 tons per year.	Same as Alternative 2	Similar to Alternative 2	Similar to Alternative 2	Similar to Alternative 2

DEIS Section	Issue Category	Alternative 1 – No Action	Alternative 2 – Near West Proposed Action	Alternative 3 – Near West – Ultrathickened	Alternative 4 – Silver King	Alternative 5 – Peg Leg	Alternative 6 – Skunk Camp
3.6.2.2; 3.6.4.2	8-3. Quantitative assessment of total mine emissions (lb/hour and tons/year), compared with the current total regional emissions (tons/year), including criteria and other pollutants (carbon monoxide, lead, sulfur dioxide, nitrogen dioxide, particulate matter, and carbon dioxide). Include tabulation of greenhouse gas emissions of CO_2, CH_4, and N_2O. Depict location of sources for considered alternatives	No impacts anticipated.	CO: 616 tons/year; 4,531 µg/m3 project (1-hour), 8,081 µg/m3 combined with background. NO2: 118 tons/year; 138 µg/m3 project (1-hour), 146 µg/m3 combined with background. PM10: 329 tons/year; 26 µg/m3 project (24-hour), 97 µg/m3 combined with background. PM2.5: 78 tons/year; 11 µg/m3 project (24-hour), 18 µg/m3 combined with background. SO2: 18 tons/year; 92 µg/m3 project (1-hour), 117 µg/m3 combined with background. Lead: 0.017 tons/year, below analysis threshold of 0.6 tons/year. CO2 and greenhouse gas: 173,000 equivalent tons/year.	Same as Alternative 2	Similar to Alternative 2	Similar to Alternative 2	Similar to Alternative 2

DEIS Section	Issue Category	Alternative 1 – No Action	Alternative 2 – Near West Proposed Action	Alternative 3 – Near West – Ultrathickened	Alternative 4 – Silver King	Alternative 5 – Peg Leg	Alternative 6 – Skunk Camp
3.6.4.2	8-4. Quantitative assessment of the ability to meet air quality standards, include impacts based on representative background air quality levels and analyze cumulative emissions and impacts	No impacts anticipated.	The analysis of air quality impacts for the proposed action and alternatives shows that all impacts would be within the ambient air quality standards and are below the PSD increments. The proposed emission sources would comply with applicable regulations, and impacts on air quality-related values would be within the established thresholds for of acceptability.	Same as Alternative 2	Similar to Alternative 2	Similar to Alternative 2	Similar to Alternative 2

DEIS Section	Issue Category	Alternative 1 – No Action	Alternative 2 – Near West Proposed Action	Alternative 3 – Near West – Ultrathickened	Alternative 4 – Silver King	Alternative 5 – Peg Leg	Alternative 6 – Skunk Camp
3.6.2.2	8-5. Quantitative assessment of the off-site impacts of hazardous or toxic air pollutants compared to health-based levels	No impacts anticipated.	The ability to meet air quality standards is considered protective of public health. In addition, levels of metals deposition associated with particulate emissions were estimated and compared with Regional Screening Levels for which the EPA has derived carcinogenic and/or non-carcinogenic chronic health effects. For all alternatives, the estimated human health risk associated with the maximum air concentrations of inorganic metals is less than established thresholds.	Same as Alternative 2	Similar to Alternative 2	Similar to Alternative 2	Similar to Alternative 2

DEIS Section	Issue Category	Alternative 1 – No Action	Alternative 2 – Near West Proposed Action	Alternative 3 – Near West – Ultrathickened	Alternative 4 – Silver King	Alternative 5 – Peg Leg	Alternative 6 – Skunk Camp
3.6.4.2	8-6. Quantitative assessment of the ability to meet NAAQS for criteria pollutants (carbon monoxide, lead, sulfur dioxide, nitrogen dioxide, ozone, and particulate matter), as modeled at the perimeter fence line of the mine facility, taking into account all mobile and stationary emission sources. Include spatial depictions of impacts for the area around the mine and alternative sites	Existing and ongoing impacts to air quality from fugitive dust and vehicle emissions are expected to increase over time with continued population growth in central Arizona. However, it is expected that monitoring and remedial actions by Maricopa County, Pinal County, and ADEQ would be effective in keeping these gradual changes within NAAQS.	None of the predicted results are anticipated to exceed the NAAQS at the ambient air boundary/fence line.	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2

DEIS Section	Issue Category	Alternative 1 – No Action	Alternative 2 – Near West Proposed Action	Alternative 3 – Near West – Ultrathickened	Alternative 4 – Silver King	Alternative 5 – Peg Leg	Alternative 6 – Skunk Camp
3.6.4.2	8-7. Quantitative assessment of the impacts at Class I airsheds, specifically, changes to air quality–related values (AQRVs) of visibility, ozone, and deposition of sulfur dioxide and nitrogen oxides, as modeled at perimeter of Class I airsheds, and compared with current deposition rates and critical loads[27]	No impacts anticipated.	All impacts are projected to be less than the PSD increments at the Class I areas and, except for the Superstition Wilderness Area, would have an insignificant[28] impact at those areas. The highest 24-hour impacts of PM_{10} and $PM_{2.5}$ emissions on air quality at the Superstition Wilderness Area consume up to 50% of the Class I PSD increments. Sulfur and nitrogen deposition impacts are lower than thresholds established by guidance.	Same as Alternative 2	Similar to Alternative 2	Similar to Alternative 2	Similar to Alternative 2

[27] See Federal Land Managers' Air Quality Related Values Work Group (FLAG) Phase I Report—Revised (2010) Natural Resource Report NPS/NRPC/NRR—2010/232.

[28] Comparisons to the PSD Class I Significant Impact Levels are provided for information only. No formal further analysis is required because the proposed action and alternatives do not trigger review and approval under the PSD regulations.

DEIS Section	Issue Category	Alternative 1 – No Action	Alternative 2 – Near West Proposed Action	Alternative 3 – Near West – Ultrathickened	Alternative 4 – Silver King	Alternative 5 – Peg Leg	Alternative 6 – Skunk Camp
3.6.4.2	8-8. Assessment using best available science of long-term trends in precipitation and temperature that may affect resources	Increases in global surface air temperatures in the Southwest have caused markedly increased average annual temperatures and reduced water storage due to early spring snowpack runoff. The trends in temperature and effects of snowmelt runoff, with declining river flow, are predicted to continue into the foreseeable future.	The proposed action would lead to emissions of greenhouse gases based largely on fuel use by mobile sources with a minor contribution from process combustion sources. The total greenhouse gas emissions would amount to 173,328 tons per year, based on year 14 with the highest emission rates. Project emissions would contribute to ongoing climate trends.	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2

DEIS Section	Issue Category	Alternative 1 – No Action	Alternative 2 – Near West Proposed Action	Alternative 3 – Near West – Ultrathickened	Alternative 4 – Silver King	Alternative 5 – Peg Leg	Alternative 6 – Skunk Camp
	Issue 9A: Long-term Land Stability – Subsidence						
3.2.4	9A-1. Quantitative assessment of the extent, amount, and timing of land subsidence, with estimates of uncertainty.	No changes from current conditions are anticipated.	Subsidence crater is estimated to first become evident at the surface at Oak Flat in mine year 6 or 7. At mine closure subsidence crater is expected to be approximately 800–1,100 feet deep and approximately 1.8 miles in diameter. Modeling indicates there would be no damage to Apache Leap, Devil's Canyon, or U.S. 60. Monitoring would take place and Resolution Copper has stated they would modify mining plans if it appears any of these areas would be impacted.	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2
3.2.4	9A-2. [REVISED][29] Qualitative assessment of the potential to impact caves or karst resources, and paleontological resources.	No changes from current conditions are anticipated.	A small area of Martin limestone with potential paleontological resources is within the footprint of Alternative 2; otherwise, no impacts to cave/karst resources or paleontological resources are anticipated.	Same as Alternative 2	No impacts to cave/karst resources or paleontological resources are anticipated.	No impacts to cave/karst resources or paleontological resources are anticipated.	No impacts to cave/karst resources or paleontological resources are anticipated.

[29] This issue factor originally focused solely on caves and karst resources. It has been expanded to include paleontological resources. These two resources are similar in that assessment of the potential to occur is largely based on types of geologic units present.

DEIS Section	Issue Category	Alternative 1 – No Action	Alternative 2 – Near West Proposed Action	Alternative 3 – Near West – Ultrathickened	Alternative 4 – Silver King	Alternative 5 – Peg Leg	Alternative 6 – Skunk Camp
	9A-3. [DROPPED][30]						
	Issue 9B: Long-Term Land Stability – Impact to Existing Landscape Productivity, Stability, and Function						
	9B-1. [DROPPED][31]						
3.3.4.2	9B-2. Quantitative level of disturbance leading to lost soil productivity (acres)	No loss of soil productivity expected.	The level of impact, soil, productivity responses, and revegetation success potential is described in section 3.3.4. (see DEIS tables 3.3.4-1 and 3.3.4-2). Total facility disturbance and impacts to productivity 10,033 acres.	Same as Alternative 2	Total facility disturbance and impacts to productivity is 10,861 acres.	Total facility disturbance and impacts to productivity for the east pipeline option is 17,153 acres. Total facility disturbance and impacts to productivity for the west pipeline option is 17,530 acres.	Total facility disturbance and impacts to productivity for north pipeline option is 16,116 acres Total facility disturbance and impacts to productivity for the south pipeline option is 16,557 acres.

[30] The original issue factor expected to be analyzed was: “Qualitative assessment of the impact of the project to seismic activity.” This issue factor largely overlapped with issue factor 5A-2 that deals with geologic hazards. Issue factor 5A-2 has been modified to incorporate seismic activity specifically, and issue factor 9A-3 has been dropped.

[31] The original issue factor expected to be analyzed was: “Qualitative assessment of long-term stability of tailings and other mine facilities, including expected results of reclamation.” This is duplicated by issue factors 5B-1 and 5B-2 (for tailings stability), and issue factor 9B-3 (for expected results of reclamation).

DEIS Section	Issue Category	Alternative 1 – No Action	Alternative 2 – Near West Proposed Action	Alternative 3 – Near West – Ultrathickened	Alternative 4 – Silver King	Alternative 5 – Peg Leg	Alternative 6 – Skunk Camp
3.3.4.2	9B-3. Qualitative and quantitative assessment of the potential for revegetation of tailings and other mine facilities, using data (where available and if equivalent) from other mine site revegetation efforts conducted in central and southern Arizona	Under this alternative there would be no tailings or other significant changes to existing mine facilities.	Analysis findings show that the following revegetation efforts from reclamation a minimum of 8% of vegetation cover (including both native and non-native species) can be consistently be established within project disturbance areas. Effects would remain including the complete loss during operations of soil productivity, vegetation, and functioning ecosystems within the area of disturbance, and eventual recovery after reclamation, though not likely to the level of desired conditions or potentially over extremely long time frames.	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2
	9B-4. [DROPPED][32]						

[32] The original issue factor expected to be analyzed was: “Qualitative evaluation of alteration of soil productivity and soil development.” This is duplicated by issue factor 9B-2.

DEIS Section	Issue Category	Alternative 1 – No Action	Alternative 2 – Near West Proposed Action	Alternative 3 – Near West – Ultrathickened	Alternative 4 – Silver King	Alternative 5 – Peg Leg	Alternative 6 – Skunk Camp
3.7.3.4	9B-5. [REVISED][33] Qualitative assessment of the changes in sediment delivery to downstream streams and washes.	No impacts to sediment yield would occur.	Changes in magnitude of peak flow and amount of flow would reduce sediment transport and bedload transport. Effects are not expected to be substantial in a sediment-transport limited system.	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2
	Issue 10: Recreation Resources						
3.9.4.2	10-1. Quantitative assessment of acres that would no longer meet current forest plan Recreation Opportunity Spectrum designations	No impacts anticipated.	Under Alternative 2, based on the Recreation Opportunity Spectrum (ROS) designation of user experiences, direct removal of 5,288 acres of the semi-primitive motorized setting, and 2,215 acres within the roaded natural setting.	Same as Alternative 2	Alternative 4 would remove 5,548 acres of the semi-primitive motorized setting and 2,078 acres within the roaded natural setting.	Alternative 5 (east option) would remove 986 acres of the semi-primitive motorized setting, 1,209 acres of the semi-primitive non-motorized setting, and 1,977 acres of the roaded natural setting. Alternative 5 (west option) would remove 1,173 acres of the semi-primitive motorized setting, and 1,453 acres of the roaded natural setting.	Alternative 6 (north option) would remove 1,665 acres of the semi-primitive motorized setting, and 1,740 acres of the roaded natural setting. Alternative 6 (south option) would remove 1,617 acres of the semi-primitive motorized setting, and 2,054 acres of roaded natural setting.

[33] The original issue factor expected to be analyzed was: “Quantitative assessment of the changes in sediment delivery to Queen Creek, Arnett Creek, or other key streams and washes (tons/year), compared with background sediment loading.” This factor was changed to a qualitative assessment of sediment yields, due to lack of background data on sediment concentrations or current sediment loss.

DEIS Section	Issue Category	Alternative 1 – No Action	Alternative 2 – Near West Proposed Action	Alternative 3 – Near West – Ultrathickened	Alternative 4 – Silver King	Alternative 5 – Peg Leg	Alternative 6 – Skunk Camp
2.2	10-2. Quantitative assessment of acres of the Tonto National Forest that would be unavailable for recreational use, for various phases of mine life and reclamation	No impacts anticipated.	All public access would be eliminated on 4,909 acres within the tailings storage facility fence line during construction, operations, and until reclamation is completed, which likely would be decades after closure. The entirety of the Oak Flat Federal Parcel would no longer be public land, though some access could remain during operations.	Same as Alternative 2	All public access would be eliminated on 5,661 acres within the tailings storage facility fence line during construction, operations, and until reclamation is completed, which likely would be decades after closure.	All public access would be eliminated on 10,782 acres within the tailings storage facility fence line during construction, operations, and until reclamation is completed, which likely would be decades after closure.	All public access would be eliminated on 10,072 acres within the tailings storage facility fence line during construction, operations, and until reclamation is completed, which likely would be decades after closure. However, these lands are currently private and Arizona State Trust lands, and would remain private lands after closure of the mine with no expectation of public access.
	10-3. [DROPPED][34]						
3.5.4	10-4. Quantitative assessment of miles of NFS roads lost, for various phases of mine life and reclamation	No impacts anticipated	A total of 8.0 miles of NFS roads would be lost due to the West Plant Site, East Plant Site, and filter plant and loadout facility. For the tailings facility, 21.7 miles of NFS roads would be lost and decommissioned.	Same as Alternative 2	Under Alternative 4, a total of 17.7 miles of NFS roads would be lost to the tailings storage facility.	Alternative 5 would not have loss to NFS roads but would result in the loss or decommissioning of 29 miles of BLM inventoried routes.	Alternative 6 would be located on private lands and impact 5.7 miles of Dripping Springs Road.

[34] The original issue factor expected to be analyzed was: "Quantitative assessment of change in visitor uses." This is largely the same information considered by issue factor 2A-5, which looked at socioeconomic effects of changes in tourism and recreation.

DEIS Section	Issue Category	Alternative 1 – No Action	Alternative 2 – Near West Proposed Action	Alternative 3 – Near West – Ultrathickened	Alternative 4 – Silver King	Alternative 5 – Peg Leg	Alternative 6 – Skunk Camp
3.4.4	10-5. Qualitative assessment of potential for noise to reach recreation areas (i.e., audio "footprint")	No impacts anticipated.	Under most conditions, predicted noise during construction and operation as sensitive receptors representing recreation users are below thresholds of concern.	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2	Noise levels along Dripping Springs Road exceed thresholds of concern. No residual impacts after mitigation applied (new access road).
3.9.4; 3.11.4	10-6. Qualitative assessment of impacts on solitude in designated wilderness and other backcountry areas	No impacts anticipated.	Visitors to the Superstition Wilderness, Picketpost Mountain, and Apache Leap would have foreground and background views of the Alternative 2 facilities from trails and overlooks, and the recreation setting from certain site-specific views would change if the tailings storage facility were visible.	Same as Alternative 2	Same as Alternative 2	Visitors to the White Canyon Wilderness would have background views of the tailings storage facility east pipeline corridor from some trails and overlooks, and the recreation setting from certain site-specific views would change if the tailings storage facility east pipeline corridor were visible.	The tailings storage facility would not be visible from any designated wilderness areas, however the southern tailings pipeline corridor would be visible from trails and overlooks on Picketpost Mountain, and the northern tailings pipeline corridor would be visible from the Superstition Wilderness.
	10-7. [DROPPED][35]						

[35] The original issue factor expected to be analyzed was: "Quantitative assessment of hunter days lost." This is largely the same information considered by issue factor 2A-5, which looked at socioeconomic effects of changes in tourism and recreation.

DEIS Section	Issue Category	Alternative 1 – No Action	Alternative 2 – Near West Proposed Action	Alternative 3 – Near West – Ultrathickened	Alternative 4 – Silver King	Alternative 5 – Peg Leg	Alternative 6 – Skunk Camp
3.9.4	10-8. Quantitative assessment of miles of Arizona National Scenic Trail, NFS trails, or other known trails requiring relocation, and qualitative assessment of user trail experience	No impacts anticipated.	0.07 miles of the tailings pipeline corridor would intersect the Arizona Trail. NFS Road 982 would also be intersected by the tailings pipeline corridor. Resolution Copper will construct an “overpass” for the tailings corridors that would span the Arizona Trail.	Same as Alternative 2.	Would require 3.05 miles of the Arizona Trail to be closed and relocated to an area that would be safe for public use. The new construction would require a different trailway approach and exit in addition to the 3.05-mile direct loss of Arizona Trail.	The Arizona Trail would be intersected by 0.18 mile of the proposed tailings storage facility east pipeline option, in the Passage 16 segment. Resolution Copper would construct an “overpass” for the tailings corridors that would span the Arizona Trail.	Impacts from south pipeline option are similar to Alternative 2.
3.9.5	10-9. Qualitative assessment of increased pressure on other areas, including roads and trails/trailheads, from displacement and relocation of recreational use as a result of mine facilities	No impacts anticipated.	It is likely that increased use would occur on other nearby lands that provide similar experiences, depending upon the recreational user type. A minor to moderate increase in user activity would be expected to occur in recreational use areas similar to those displaced by the project elsewhere in the Globe Ranger District, as well as on other Federal, State, and County lands.	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2

DEIS Section	Issue Category	Alternative 1 – No Action	Alternative 2 – Near West Proposed Action	Alternative 3 – Near West – Ultrathickened	Alternative 4 – Silver King	Alternative 5 – Peg Leg	Alternative 6 – Skunk Camp
	Issue 11: Impacts to Scenic Resources						
3.11.4	11-1. [REVISED][36] Acres of Tonto National Forest land that would no longer meet current forest plan Visual Quality Objective designations.	No impacts anticipated.	Analysis finds that within the project footprint the following acreage totals have designations that would not allow for the proposed project activities: 393 acres of Retention, and 5,184 acres of Partial Retention.	Same as Alternative 2	Under Alternative 4, analysis finds that within the project footprint the following acreage totals have designations that would not allow for the proposed project activities: 371 acres of Retention, and 4,663 acres of Partial Retention.	Under Alternative 5, analysis finds that within the project footprint the following acreage totals have designations that would not allow for the proposed project activities: 691 (east) or 530 (west) acres of Retention, and 1,905 (east) or 1,824 (west) acres of Partial Retention.	Under Alternative 6, analysis finds that within the project footprint the following acreage totals have designations that would not allow for the proposed project activities: 676 (north) or 771 (south) acres of Retention, and 2,043 (north) or 2,225 (south) acres of Partial Retention.
3.11.4	11-2. [REVISED][37] Anticipated changes in landscape character from key analysis viewpoints, for various phases of mine life and reclamation.	No impacts anticipated.	The analysis of anticipated changes in landscape character from key analysis viewpoints for Alternative 2 is too extensive to summarize here and is presented in tables 3.11.4-1, 3.11.4-3, 3.11.4-4, and 3.11.4-5.	Same as Alternative 2	Analysis of anticipated changes in landscape character for Alternative 4 is presented in tables 3.11.4-6 and 3.11.4-7.	Analysis of anticipated changes in landscape character for Alternative 5 is presented in tables 3.11.4-8 and 3.11.4-9.	Analysis of anticipated changes in landscape character for Alternative 6 is presented in table 3.11.4-10.

[36] The original issue factor expected to be analyzed was: “Quantitative assessment of acres that would no longer meet current forest plan Scenic Integrity Objective designations.” This was changed to align with terminology currently in use on the Tonto National Forest.

[37] The original issue factor expected to be analyzed was: “Qualitative assessment/degree of change in landscape character from key analysis viewpoints, for various phases of mine life and reclamation.” This factor was updated to better reflect the analysis presented.

DEIS Section	Issue Category	Alternative 1 – No Action	Alternative 2 – Near West Proposed Action	Alternative 3 – Near West – Ultrathickened	Alternative 4 – Silver King	Alternative 5 – Peg Leg	Alternative 6 – Skunk Camp
3.11.4	11-3. [REVISED][38] Miles of project area visibility along major thoroughfares in the area (i.e., U.S. 60, State Route [SR] 79 and SR 177).	No impacts anticipated.	The Alternative 2 facilities would be visible along 21.2 miles of U.S. 60 and 2.5 miles of SR 177.	Same as Alternative 2	Alternative 4 facilities would be visible along 18.3 miles of U.S. 60 and 3.6 miles of SR 177.	Alternative 5 facilities would be visible along 1.5 miles of U.S. 60 and 1.5 miles of SR 177.	The Alternative 6 tailings facilities would not be visible from either U.S. 60 or SR 177.
	11-4. [DROPPED][39]						
3.11.4	11-5. [REVISED][40] Potential for increase in sky brightness resulting from the mine facility and mine-related vehicle lighting.	No impacts anticipated.	Lighting at the East Plant Site, West Plant Site, and tailings facility would be visible and noticeable at night from the town of Superior, U.S. 60, Boyce Thompson Arboretum, the Arizona Trail, and the surrounding national forest landscape.	Same as Alternative 2	Same as Alternative 2	The visibility of lighting at the East Plant Site and West Plant Site would be unchanged from Alternative 2. Lighting at the Alternative 5 tailings location may be visible to nighttime recreationists in the area, Arizona Trail users, and persons traveling on the Florence-Kelvin Highway.	The visibility of lighting at the East Plant Site and West Plant Site would be unchanged from Alternative 2. However, there would be fewer observers of the night sky in the area of the tailings because of the remote location of the facility.
	Issue 12: Impacts to Transportation/ Access						
3.5.4	12-1. Quantitative assessment of change in type and pattern of traffic by road and vehicle type	Traffic volumes will continue to increase at an average 2% annual growth rate over the next 10 to 20 years, resulting in increased traffic levels on all roads in the area.	64 trips expected during the peak hour in peak construction and 46 trips expected during the peak hour at normal operations.	Same as Alternative 2	88 trips expected during the peak hour in peak construction and 58 trips expected during the peak hour at normal operations.	Same as Alternative 2	Same as Alternative 2

[38] The original issue factor expected to be analyzed was: "Quantitative assessment of miles of U.S. 60, State Route (SR) 79 or SR 177 with direct line-of-sight views of the project area." The factor was revised for added clarity.

[39] The original issue factor expected to be analyzed was: "Quantitative assessment of miles of project area visibility along concern level 1 and 2 roads and trails." This factor was eliminated because the Tonto National Forest does not use the term "concern level" roads or trails in its planning and Forest management efforts.

[40] The original issue factor expected to be analyzed was: "Qualitative assessment of increase in sky brightness resulting from mine facility and vehicle lighting." The factor was revised for added clarity.

DEIS Section	Issue Category	Alternative 1 – No Action	Alternative 2 – Near West Proposed Action	Alternative 3 – Near West – Ultrathickened	Alternative 4 – Silver King	Alternative 5 – Peg Leg	Alternative 6 – Skunk Camp
3.5.4	12-2. Quantitative assessment of the change in level of service on potential highway routes and local roads	With increasing traffic, due to normal background growth and development of the area, the intersections in the project area are generally expected to operate within an acceptable LOS in years 2022 and 2027. The Combs Road/Schnepf Road intersection is expected to operate with a side street LOS E/F by year 2022 through 2027.	Project-related traffic would contribute to decreased LOS at many intersections; unacceptable LOS (E/F) caused by project-related traffic occurs at Silver King Mine Road/U.S. 60 (construction and operations), Main Street/U.S. 60 (construction and operations), SR177/U.S. 60 (construction), and Magma Mine Road/U.S. 60 (operations).	Same as Alternative 2	Similar to Alternative 2	Similar to Alternative 2	Similar to Alternative 2
	12-3. [DROPPED][41]						
	Issue 13: Impacts Caused by Mine-Related Noise and Vibration						
	13-1. [DROPPED][42]						
3.4.4	13-2. Qualitative assessment of the ability of alternatives to meet rural landscape expectations	No impacts anticipated.	Under most conditions, predicted noise and vibration during construction and operation at sensitive receptors are below thresholds of concern; rural character would not change due to noise.	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2	Noise levels along Dripping Springs Road exceed thresholds of concern. No residual impacts after mitigations applied (new access road), therefore rural character would not change due to noise.

[41] The original issue factor expected to be analyzed was: "Quantitative assessment of roads decommissioned by the mine and roads lost to motorized access." This is duplicated by issue factor 10-4.

[42] The original issue factor expected to be analyzed was: "Qualitative assessment of the potential for noise to reach recreation areas." This is duplicated by issue factor 10-5.

DEIS Section	Issue Category	Alternative 1 – No Action	Alternative 2 – Near West Proposed Action	Alternative 3 – Near West – Ultrathickened	Alternative 4 – Silver King	Alternative 5 – Peg Leg	Alternative 6 – Skunk Camp
3.4.4	13-3. Quantitative assessment of noise levels (A-weighted decibels (dBA)) and geographic area impacted from mine operations, blasting, and traffic and qualitative assessment of effects of noise at nearby residences and sensitive receptors	No impacts anticipated.	Noise impacts were modeled for 15 sensitive receptors representing residential, recreation, and conservation land uses. Under most conditions, predicted noise and vibrations during construction and operation, for both blasting and non-blasting activities, at sensitive receptors are below thresholds of concern.	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2	Noise levels along Dripping Springs Road exceed thresholds of concern. No residual impacts after mitigation applied (new access road).
	13-4. [DROPPED][43]						
3.4.5.1	13-5. Qualitative assessment of effects of vibrations from blasting and mine operations at nearby residences and sensitive receptors	No impacts anticipated.	The vibration analysis indicates that within given levels of explosive loading, neither blasting nor non-blasting vibrations exceed selected thresholds based on structural damage.	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2
	Issue 14: Impacts to Land Ownership and Boundary Management						
	14-1. [DROPPED][44]						

[43] The original issue factor expected to be analyzed was: “Quantitative assessment of acres of habitat impacted from noise, vibrations, and light, at frequencies pertinent to species of concern.” This was duplciated by issue factor 7B-4.

[44] The original issue factor expected to be analyzed was “Quantitative assessment of acres of public lands no longer accessible, for various phases of the mine life and reclamation.” This is duplicated by issue factor 10-2.

DEIS Section	Issue Category	Alternative 1 – No Action	Alternative 2 – Near West Proposed Action	Alternative 3 – Near West – Ultrathickened	Alternative 4 – Silver King	Alternative 5 – Peg Leg	Alternative 6 – Skunk Camp
1.4.2; Appendix B	14-2. Quantitative assessment of lands that will be conveyed to public ownership through the land exchange (i.e., approximately 5,344 acres in all parcel groups)	No exchange of lands would occur.	1,224 acres of land will be conveyed to the National Forest Service and 4,150 acres of land will be conveyed to the BLM.	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2
3.16.4.2	14-3. Quantitative assessment of changes to acreage of grazing allotments, loss of animal unit months (AUMs), and qualitative assessment of impact from loss of grazing-related facilities (waters, stock tanks, roads, fences)	No impacts anticipated.	Under Alternative 2, affected grazing allotments would experience a reduction of 8,572 acres and 666 AUMs over six allotments and 17 grazing-related facilities would also be lost.	Same as Alternative 2	Under Alternative 4 there would be a reduction in 9,399 acres and 737 AUMs over six allotments, and 17 grazing-related facilities would be lost.	Under Alternative 5, for the east pipeline corridor: There would be a reduction in 15,672 acres and 1,378 AUMs over 10 allotments, and six grazing-related facilities would be lost. For the west pipeline corridor: There would be a reduction in 16,186 acres and 2,380 AUMs over 12 allotments, and six grazing-related facilities would be lost.	Under Alternative 6, for the north pipeline corridor: There would be a reduction of 14,747 acres and 2,674 AUMs over nine allotments, and 13 grazing-related facilities would be lost. For the south pipeline corridor: There would be a reduction in 15,209 acres and 2,745 AUMs over nine allotments, and 13 grazing-related facilities would be lost.
	14-4. Qualitative assessment of changes in fencing, boundary markers, and survey markers	No impacts anticipated.	It is anticipated that implementation of any action alternative would damage, destroy, or obliterate corner monuments and landownership boundaries (e.g., through ground-clearing activities or burial beneath tailings).	It is anticipated that implementation of any action alternative would damage, destroy, or obliterate corner monuments and landownership boundaries (e.g., through ground-clearing activities or burial beneath tailings).	It is anticipated that implementation of any action alternative would damage, destroy, or obliterate corner monuments and landownership boundaries (e.g., through ground-clearing activities or burial beneath tailings).	It is anticipated that implementation of any action alternative would damage, destroy, or obliterate corner monuments and landownership boundaries (e.g., through ground-clearing activities or burial beneath tailings).	It is anticipated that implementation of any action alternative would damage, destroy, or obliterate corner monuments and landownership boundaries (e.g., through ground-clearing activities or burial beneath tailings).

DEIS Section	Issue Category	Alternative 1 – No Action	Alternative 2 – Near West Proposed Action	Alternative 3 – Near West – Ultrathickened	Alternative 4 – Silver King	Alternative 5 – Peg Leg	Alternative 6 – Skunk Camp
	14-5. [DROPPED][45]						
3.2.4	14-6. Qualitative assessment of impact to mining claims	Non–Resolution Copper unpatented load or placer mining claims are located under the tailings storage facility and pipeline corridor.	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2

[45] The original issue factor expected to be analyzed was: “Qualitative assessment of impacts to regional land conservation efforts.” This factor cannot be assessed until a full mitigation package is available that includes additional lands that may be brought forth in repsonse to Clean Water Act Section 404 permitting of Endangered Species Act Section 7 consultation. At this time, regional conservation land efforts do not appear to be impacted in any specific way.

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APPENDIX F. ALTERNATIVES CONSIDERED BUT DISMISSED FROM DETAILED ANALYSIS

Alternatives Considered but Eliminated from Detailed Study

Federal agencies are required under the National Environmental Policy Act (NEPA) to rigorously explore and objectively evaluate all reasonable alternatives which were eliminated from detailed study, and to briefly discuss the reasons for their having been eliminated (40 Code of Federal Regulations [CFR] 1502.14). All comments received from the public, cooperating agencies, tribes, and the project team during the scoping period in response to the proposed action that provided suggestions for alternative methods for achieving the purpose and need were considered for analysis (SWCA Environmental Consultants 2017b). Some of these alternatives were determined to be outside the scope of the project, duplicative of the alternatives already being considered in detail, unable to fulfill the purpose and need, technically or economically infeasible, or involved components or actions that would cause unnecessary environmental harm, and therefore, were not considered for detailed analysis. A number of alternatives were initially considered and analyzed but later dismissed from further detailed analysis in the environmental impact statement (EIS) for reasons summarized in the following text. Additional information can be found in the "Resolution Copper Project and Land Exchange Environmental Impact Statement Draft Alternatives Evaluation Report" (SWCA Environmental Consultants 2017a).

Alternative Mining Techniques

Substantial public comments were received concerning Resolution Copper Mining, LLC's (Resolution Copper's) proposed panel caving mining technique (panel caving is a form of block caving), in particular requesting that alternative mining techniques be considered or required. Public comments asked for alternatives considering the following items:

- use of traditional mining methods, including less-mechanized forms of mining,
- investigation of alternatives that would result in minimal surface disturbance, and
- use of alternative mining methods to reduce the volume of tailings produced.

The proposed panel caving mining method is seen as having two major drawbacks. First, panel caving results in the creation of a subsidence area at the surface, which impacts a variety of resources. Second, because panel caving does not leave any opening or cavity belowground, there is no opportunity to backfill tailings as a potential disposal alternative. The U.S. Department of Agriculture Forest Service (Forest Service) agreed that if an alternative mining method were found to be reasonable, it could reduce certain resource impacts, and the agency undertook an investigation into the technical and economic feasibility of using alternative mining techniques.

OPEN-PIT MINING

Open-pit mining was considered but eliminated from detailed analysis because it would result in surface disturbances greater than those in the proposed action (panel caving), causing unnecessary environmental harm. Specifically:

- The footprint of the open pit would need to be approximately 10,000 acres, which is eight times larger than the projected maximum disturbance from subsidence (approximately 1,200 acres).
- The resulting pit would result in the removal of all of Oak Flat, all of Apache Leap, approximately 4 miles of U.S. Route 60, approximately 3 miles of Queen Creek, and approximately 3 miles of Devil's Canyon.
- The pit would have a stripping ratio (waste rock to ore) of 35:1 and would result in approximately 205 billion tons of waste rock. This represents more than 100 times more volume than the

projected volume of tailings under the General Plan of Operations (GPO). The waste rock generated from mining would need to be disposed of at some surface location, and a tailings impoundment would still be required.

ALTERNATIVE UNDERGROUND MINING TECHNIQUES

The term “stope” used in mining simply indicates an underground excavation or room, and the term “stoping” refers to any underground mining technique that removes ore from these areas. A spectrum of underground mining techniques was assessed, including naturally supported stoping methods (open stoping, open stoping with pillars), artificially supported stoping methods (shrinkage stoping, overhand and underhand cut-and-fill), other caved stoping methods aside from panel caving (sub-level caving), and other stoping methods like vertical crater retreat. These alternative underground mining techniques are described in detail in the “Resolution Copper Project and Land Exchange Environmental Impact Statement Draft Alternatives Evaluation Report” (SWCA Environmental Consultants 2017a). Each of these stoping methods is suited to certain characteristics of an ore body, including ore and host rock strength, the depth and type of overburden or cap rock, and the size and shape of the ore body. As shown in table F-1, very few of these underground stoping methods have characteristics that are well suited to the Resolution copper deposit, even though technically these methods could be used.

Table F-1. Summary of underground stoping methods and their applicability to the Resolution Copper Mine ore deposit

Underground Stoping Method	Ideal Ore Body Characteristics	Ideal Ore Strength	Ideal Host Rock Strength	Backfill with Tailings Materials
Resolution Copper Mine Deposit	*Low grade, massive, thick*	*Weak–Moderate*	*Weak–Moderate*	*No*
Cut-and-fill	High grade, irregular, narrow to wide	Strong	Weak*	Yes
Open stoping	Small	Strong	Strong	Possible
Open stoping with pillar support	Low grade, horizontal or flat dipping	Strong	Strong	Possible
Shrinkage stoping	Fairly high grade, narrow to wide (4 to 100 feet) thick	Strong	Moderate*	Possible
Vertical crater retreat stoping	>40 feet thick	Strong	Strong	Possible

***** Indicates a match with the characteristics of the Resolution Copper Mine ore deposit

While there are other underground stoping techniques that could physically be applied to the Resolution copper deposit, each of the alternative underground mining methods assessed was found to have higher operational costs than panel caving. Higher operations costs would result in a shift in the “cutoff grade” of ore that could be profitably mined. The cutoff grade (given as a percentage) is the lowest grade of copper for a ton of ore that equals the cost of stripping, drilling, blasting, mining, hauling, crushing, and processing the ore (as well as administrative costs, taxes, and other overhead costs), given the current price and mill recovery.

The current cutoff grade as proposed by Resolution Copper is a greater-than-1-percent copper shell, which would result in the greatest potential volume of ore from within the deposit that can be profitably mined. The alternative underground techniques considered would shift the cutoff grade much higher and substantially reduce the amount of ore that could be profitably mined. As shown in table F-2, at a 2 percent cutoff grade, it is estimated that less than 20 percent of the deposit identified by Resolution Copper could be mined. At a 3 percent cutoff grade, it is estimated that less than 1 percent of the deposit

could be mined. For comparison, the average grade of ore removed from the historic Magma Mine has been reported to be 5 percent. This higher grade of ore was able to support a cut-and-fill mining technique.

Table F-2. Estimated volume of Resolution Copper Mine deposit at various cutoff grades

Cutoff Grade	Estimated Volume (tons)	Percentage of Volume Proposed to Be Mined in GPO (%)	Source	Average Grade of Ore above the Cutoff Grade
1%	1,969,000,000	100	Resolution Copper	1.54%
2%	386,437,500	19.6	Independent estimate from Resolution Copper data	Unknown
3%	7,545,919	0.4	Extrapolation from first two data points	Unknown
4%	1,478,469	0.08	Extrapolation from first two data points	Unknown
5%	289,676	0.02	Extrapolation from first two data points	Unknown

Reasonableness of Alternative Mining Techniques

The Forest Service recognizes and acknowledges scoping comments that suggest the use of mining techniques other than panel caving could substantially reduce impacts on surface resources, both by reducing or eliminating subsidence and by allowing the potential of backfilling tailings underground. For this reason, the potential for using alternative mining techniques was investigated explicitly during the alternatives development process.

In the end, alternative mining techniques as applied specifically to the Resolution Copper Mine deposit were not found to be reasonable, with the following rationale:

1. Panel caving is a standard mining method used in the industry and is commonly used for deposits with the grade, size, depth, and geological characteristics of the Resolution Copper Mine deposit.
2. While several underground stoping techniques could physically and technically be applied to the deposit, the ore and host rock characteristics typically favorable for these techniques differ from the characteristics of the Resolution Copper Mine deposit. While physically feasible, it is unlikely that any of these techniques would be chosen as a reasonable technique for a similar deposit.
3. Use of any of these alternative underground stoping techniques would result in higher per-ton mining costs, and as a result the cutoff grade for the deposit would need to be higher to be economically feasible. An increase in the cutoff grade from 1 percent to 2 percent removes an estimated 80 percent of the tonnage of the deposit from consideration for development. The tonnage is likely to be even lower at a 2 percent cutoff grade, as many of these areas of high-grade ore are not contiguous or continuous. Accepting this level of reduction to accommodate an alternative mining technique is not economically feasible and would not be reasonable.

This threshold of reasonableness is consistent with guidance contained in the Forest Service minerals and geology manual (Forest Service Manual [FSM] 2800) (U.S. Forest Service 2006):

> The claimant has the right to see or otherwise dispose of *all locatable minerals*, including uncommon varieties of mineral materials, on which the claimant has a valid claim. (FSM 2813.12, emphasis added)
>
> In managing the use of the surface and surface resources, the Forest Service should attempt to minimize or prevent, mitigate, and repair adverse environmental impacts on National Forest System surface and cultural resources as a result of lawful prospecting,

> exploration, mining, and mineral processing operations, as well as activities reasonably incident to such uses. This should be accomplished by imposition of reasonable conditions *which do not materially interfere with such operations*. (FSM 2817.02, emphasis added)

The Forest Service found the substantial decreases in ore development that would result by requiring an alternative mining technique would not meet the definition of reasonable, would not allow Resolution Copper to dispose of all locatable minerals on which it has valid claims, and would materially interfere with its operations. For the above reasons, alternative mining techniques were considered but eliminated from detailed analysis.

Brownfield Tailings Disposal

During scoping, public comments requested that the Forest Service identify a "brownfield" location (a site that is largely disturbed by previous activity) to store the tailings waste generated in the mining process. A list of potential brownfield sites was developed by reviewing possible mining brownfield sites in Arizona that could potentially hold all or a portion of the tailings anticipated to be produced through mining operations described in the GPO.

Fourteen existing pits or brownfield mine sites were originally considered for tailings disposal and are described in the following text.

AJO

The expected pumping distance to the Ajo pit is estimated to be over 120 miles and would cross numerous public and private jurisdictions. The environmental harm associated with long-distance transport corridors would be substantial, and this location offers only a partial disposal option and does not prevent the placement of a large tailings facility on Federal land. For these reasons, use of the Ajo pit was considered to be unreasonable and was dismissed.

CARLOTA

The Carlota site is over an existing heap leach pad and has minimal to no pit capacity for containing all of the potentially acid generating (PAG) material; tailings storage would require an embankment and expansion of this heap leach area. The site is located on a complex geological area that results in high geological and hydrogeological constraints, and tailings located here have the potential to impair water quality in Pinto Creek and would require creek diversions. Location of the tailings storage facility in this location would not address the water quality issues, and the alternative was therefore dismissed.

CASA GRANDE

Initial estimates showed that the Casa Grande pit potentially had the capacity to hold the PAG tailings material. Upon further investigation, it was determined that it does not have adequate capacity to store the PAG tailings material and is therefore not a suitable option for future tailings storage. This and other pits were also considered further as possible components of an alternative that would dispose of all tailings in multiple brownfield locations, but there was insufficient capacity to store all tailings, even with multiple locations.

COPPER QUEEN (BISBEE, ARIZONA)

Copper Queen Mine is a popular tourist attraction in Bisbee, Arizona. The mine hosts tours, includes a museum, and is visited by many tourists every year. The environmental harm associated with hundreds of miles of pipeline corridor disturbance across Federal, tribal, and other lands would be substantial.
For these reasons, it was removed from further consideration for tailings storage.

COPPERSTONE

The Copperstone site does not have the capacity to store all or even the PAG-only portion of the Resolution Copper Mine tailings; this location was therefore removed from consideration for tailings storage.

GREEN VALLEY / SIERRITA

The Green Valley/Sierrita Mine has an ongoing mining operations; for that reason, it was dismissed from further investigation.

JOHNSON CAMP

The Johnson Camp mine has the potential for future mining operations and does not have the capacity to store all or the PAG portion of the tailings. For these reasons, the site was removed from further consideration for tailings storage.

MIAMI AND INSPIRATION / MIAMI UNIT AND COPPER CITY

The Miami and Inspiration / Miami Unit and Copper City mines are located within the Pinal Creek Water Quality Assurance Revolving Fund (WQARF), which is the State of Arizona’s equivalent to Superfund. While not absolute, the legal concept of “joint and several liability” that drives Superfund means that use or ownership of these sites would potentially reflect liability on Resolution Copper Mining, LLC. Consideration of these sites was not considered reasonable and therefore they were dismissed.

PINTO VALLEY MINE

The anticipated Pinto Valley Mine operation and closure was considered; however, it was determined that the mine could still be operational at the time when tailings storage is required for the Resolution Copper Project. Because current mine life is projected through 2039, the project team dismissed this location from further investigation. Tailings storage would require an additional embankment and expansion of this area.

RAY MINE

The Ray Mine has an expected reserve life of between 2044 (ASARCO Grupo Mexico 2019) and 2066 (U.S. Army Corps of Engineers 2016) and is in the process of further expansion of a new tailings facility at Ripsey Wash as well as a land exchange with the U.S. Department of the Interior Bureau of Land Management (BLM). The Ray Mine was removed from further consideration because it is in operation and not available for tailings storage in the necessary project time frame.

RESOLUTION COPPER EAST PLANT SITE SUBSIDENCE AREA (POTENTIAL FUTURE BROWNFIELD SITE)

In addition to reviewing existing brownfields, scoping commenters recommended that the tailings be stored in the proposed Resolution Copper Project East Plant Site subsidence area. The feasibility of placement of tailings in the subsidence area, either as slurry or filtered tailings, was considered during alternatives development. In this scenario, the tailings would be placed initially on undisturbed land above the mining panels in the area that would gradually become a subsidence pit. The subsidence area would then be filled with tailings as it expanded over time. This option was dismissed for safety concerns, both aboveground and belowground. In panel caving, it is paramount to control the rate of panel caving and prevent air gaps from developing above the caved zone, which can lead to potentially catastrophic air blasts. Loading of tailings above the panel cave operation could change the rock dynamics in unexpected and unknown ways. If it involves slurry, the added aspect of drainage from above further complicates mining operations. Safety hazards exist for personnel placing tailings aboveground as well, given the active subsidence and earth movement. Overall, it was determined that this option represented unreasonable safety hazards and did not conform to industry norms.

SAN MANUEL

The expected pumping distance to the San Manuel pit is estimated to be approximately 50 miles (straight-line distance). A review of the site’s geology shows a high-angle fault in the area. Hydrogeological conditions are unknown at this time but could present additional concerns. San Manuel was originally considered to represent a reasonable option; however, Resolution Copper raised concerns about its ability to control water quality after placement of PAG tailings in the existing pit, given the proximity to the San Pedro River. These concerns were further investigated by the project team, including review of Arizona Department of Environmental Quality (ADEQ) documents related to the closure of San Manuel. The best available information at this time suggests that use of the San Manuel pit would not successfully address the single driving issue of water quality. Specifically, the disposal methodology would not prevent oxidation of PAG material and current gradients would deliver acid drainage directly to the aquifer. Further, movement of seepage into groundwater and movement of groundwater away from the pit would not be controlled, as the current hydraulic sink would be expected to disappear without a pit lake present. The groundwater gradient would potentially deliver poor-quality groundwater directly to the San Pedro River. For these reasons, the San Manuel pit was eliminated from detailed analysis in the draft EIS (DEIS).

TOHONO CYPRUS

The Tohono Cyprus site does not have the capacity to store all or the PAG portion of the tailings and was therefore eliminated from further consideration.

TWIN BUTTES

Twin Buttes has ongoing operations and future operation plans that make it infeasible for future tailings storage. The location would also require tailings to be pumped almost 100 miles (straight-line distance).

Other Alternative Tailings Disposal Locations

In response to public scoping comments, the Forest Service investigated a number of alternative tailings disposal locations (figure F-1). During the alternative evaluation process, the Forest Service reviewed the regional landscape to identify alternative locations that could potentially solve resource issues. These

locations were then combined with the alternative locations previously identified by Resolution Copper (see section 3.3.10.1 of the GPO) and evaluated to determine which locations should be dismissed and which locations should be carried forward for inclusion in the DEIS. Table F-3 presents the dismissal rationale for the tailings facility alternative locations not carried forward in the DEIS. These locations were dismissed because they do not improve upon significant issues of concern over the proposed GPO location.

Agency-Identified Alternative Tailings Disposal Locations and Techniques Considered but Ultimately Dismissed from Detailed Analysis

As noted in table F-3, the alternative of using filtered (or “dry stack”) tailings rather than slurry tailings was eventually brought forward for detailed analysis at the Silver King location, very near the West Plant Site, rather than at the GPO location. This is now Alternative 4 (described in section 2.2.6) in the DEIS.

Additionally, as a result of extensive meetings and consultations during the latter part of 2017 and early 2018, between the Tonto National Forest, the BLM, and Resolution Copper, together with information provided by the Arizona State Land Department (ASLD), BLM, and other cooperating agencies, four additional alternative tailings locations and/or alternative construction techniques came under serious consideration. The first two of these were proposed near, but not in the exact same location as, the previously considered “BGC C” alternative location shown in figure F-1 and described in table F-3.

This general location south of the Gila River came to be known as the “Peg Leg” site, after the name of a nearby wash. The major advantages it presented as an alternative tailings storage site included a) relative remoteness from population centers and other infrastructure; b) relative proximity to other ongoing and historic mining activities; c) generally level topography on a base primarily consisting of alluvial soils, rather than the more upland, rocky, steeper terrain characteristic of the GPO and Silver King locations; and d) lower recreational use and perceived scenic value than the GPO and Silver King areas.

The two “Peg Leg” alternatives that ultimately emerged were proposed to occupy approximately the same footprint south of the Gila River and west of State Route 177, but each would employ different construction techniques.

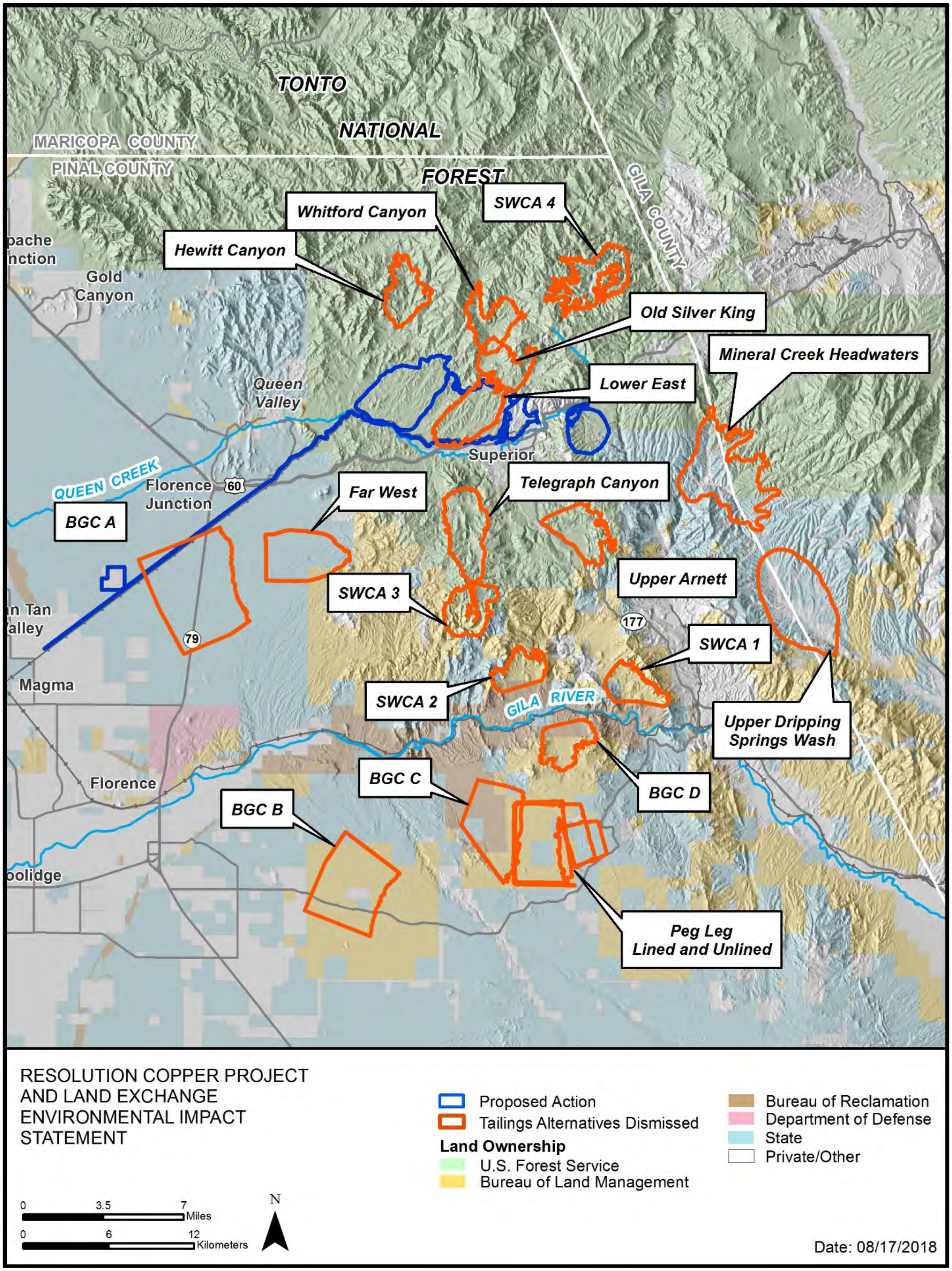

Figure F-1. Tailings facility alternative locations considered but dismissed from detailed study

Table F-3. Alternative tailings facility locations considered but dismissed from detailed analysis

Alternative Location	Rationale for Dismissal
Whitford Canyon	The location does not provide an overall improvement upon the GPO location for key resource issues: • Water resource impacts: higher tributary area relative to other alternative locations. • Very close to Superstition Wilderness designated Class II airshed; too close for permitting. • Recreation impacts: directly covers the Arizona National Scenic Trail and disrupts popular off-highway vehicle loop route connections. • Biological impacts on a larger variety of biotic communities than most of other alternatives, including on areas deemed sensitive vegetation communities.
Hewitt Canyon	The location does not provide an overall improvement upon the GPO location for key resource issues: • Water resource impacts: higher tributary area relative to other alternative locations. • Very close to Superstition Wilderness designated Class II airshed; too close for permitting. • Recreation impacts on trails and disrupts popular off-highway vehicle loop route connections. • Biological impacts on a larger variety of biotic communities than most of other alternatives, including on areas deemed sensitive vegetation communities. • Longer tailings pipeline/transfer corridor relative to other alternative locations in the Queen Creek watershed.
Telegraph Canyon	The location does not provide an overall improvement upon the GPO location for key resource issues (water resources, biological resources, recreation resources): • Water resource impacts; hydrology drainage impacts; biological impacts on Important Bird Areas and riparian areas. • Recreation impacts on roads and trails; would cover large portion of the Arizona National Scenic Trail.
Lower East	The location does not provide an overall improvement upon the GPO location for key resource issues: • Water resource impacts. • Closer to the receptor Boyce Thompson Arboretum. • Closer to U.S. Route 60 and town of Superior.
Far West	The Forest Service sent an inquiry to the Arizona State Land Department (ASLD), the landowner, regarding the potential availability at this location for a tailings facility. ASLD responded that the agency has plans for future residential development for the area and therefore it is not available at this time, or in the future, for locating a tailings facility. For this reason, the location was dismissed from further investigation.
BGC A	The location does not provide an overall improvement upon the GPO location for key resource issues: • Water resource impacts, higher number of wells nearby. • Closer to receptors (residential areas). • Potentially encroaches on area infrastructure (roads).
BGC B	The location does not provide an overall improvement upon the GPO location for key resource issues: • Water resource impact, proximity to Gila River (potentially already degraded water quality). • Closer to receptors (residential areas). • Visual resource impacts, proximity to Florence area and nearby residential areas.
BGC D	The location does not provide an overall improvement upon the GPO location for key resource issues: • Water resource impacts: stormwater management more difficult due to local terrain and proximity to the Gila River. • Recreation impacts, including proximity to the Arizona National Scenic Trail.
SWCA 1	The location does not provide an overall improvement upon the GPO location for key resource issues: • Water resource impacts: stormwater management more difficult due to local terrain and proximity to the Gila River. • Recreation impacts, including proximity to the Arizona National Scenic Trail.
SWCA 2	The location does not provide an overall improvement upon the GPO location for key resource issues: • Water resource impacts: stormwater management more difficult due to local terrain and proximity to the Gila River.

Alternative Location	Rationale for Dismissal
SWCA 3	The location does not provide an overall improvement upon the GPO location for key resource issues: • Landscape constraints (very steep terrain, occupy two watersheds, high probability of faults for landslides). • Recreation impacts, proximity to the Arizona National Scenic Trail.
SWCA 4	This location was removed from consideration for key resource issues: • Water resource impacts, drainage into Roosevelt Lake. • Encroaches on Superstition Wilderness, a Class I airshed.
Upper Arnett	This location was removed from consideration for key resource issues: • Water resource impacts, impacts Arnett Creek, higher upstream in the watershed. • Biological resources, contains more unfragmented wildlife habitat, compared with other alternatives. • Proximity to area infrastructure, State Route 177. • Design confined by highway and landscape features provides less design flexibility. • Longer tailings pipeline/transfer corridor relative to other alternative locations.
Filtered Tailings at the GPO Tailings Facility Location	In response to public scoping comments, the Forest Service considered a tailings alternative of filtered tailings (also commonly known as dry stack tailings) at the proposed GPO tailings facility location. Ultimately, the Forest Service determined that due to the logistical concerns associated with water management and the tailings pipeline/transfer corridor, the evaluation of this alternative tailings technique would occur at the Alternative 4 (Silver King) location.
Silver King	The original location as considered by Resolution Community Working Group was moved to avoid a historic cemetery, underground mine workings of Silver King, mineral estate, and private land. The Silver King location was eliminated as a suitable location for slurry impoundment for water resource concerns but is being moved forward for detailed analysis as a filtered tailings location.
BGC C	This alternative location represented the first iteration of what eventually became Alternative 5 – Peg Leg. This specific location was relocated to move off of U.S. Bureau of Reclamation withdrawn lands; once moved, it evolved into the Peg Leg – Lined and Peg Leg – Unlined alternatives (see below).
Peg Leg – Lined	See more detail in the following text.
Peg Leg – Unlined	See more detail in the following text.
Mineral Creek Headwaters	See more detail in the following text.
Upper Dripping Spring Wash	See more detail in the following text.

Peg Leg – Lined

The first, known as “Peg Leg – Lined,” would be located primarily on BLM- and ASLD-administered lands (figure F-2) and would be constructed behind a downstream-type embankment, rather than an upstream-type embankment as proposed at the GPO location, and would be fully lined.

Though not as efficient with space or materials necessary to construct as an upstream embankment, the downstream embankment configuration is considered robust and least prone to failure of all tailings embankment types. However, the great disadvantage of the downstream-type embankment is that it requires enormous amounts of non-tailings material (i.e., earthfill) to construct, and it must occupy in perpetuity a substantially greater surface area adjacent to the tailings impoundment itself. The issue with constructing a downstream embankment with borrow materials is that storage requirements would be increased by about one-third because the cyclone sand materials that are used to construct the other embankment options would need to be stored behind the borrow embankment.

Under the “Peg Leg – Lined” alternative, the PAG and non-potentially acid generating (NPAG) cells would be kept separate, rather than merging later during tailings facility development as under the GPO plan, and both cells would be fully lined with an engineered low-permeability liner or equivalent containment system that would continue to be enlarged vertically as the two cells grew in height over time. The PAG cell would be kept continuously saturated to reduce the chances for oxidation/metal leaching, and tailings would be deposited in both cells subaqueously. Any seepage from the PAG and NPAG cells would be collected via the tailings liners and recycled back into the process water, and if necessary treated prior to recycling.

All other major mine plan components such as the East Plant Site infrastructure, block-cave mining, West Plant Site processing, slurry concentrate delivery to the filter plant and loadout facility, and other utility corridors would remain unchanged from those proposed in the GPO, with the exception of a pipeline corridor needed to bring slurry tailings to the Peg Leg site.

Peg Leg – Unlined

Conscious of both the advantages and limitations presented by the downstream embankment type, the Tonto National Forest decided to conduct preliminary analysis of another embankment type and seepage control methodology at the Peg Leg site.

Rather than a downstream embankment configuration, the “Peg Leg – Unlined” alternative proposed a centerline-type embankment, in which subsequent “raises” or “lifts” to the embankment over time would be built atop earlier levels of compacted cycloned tailings and earthfill.

The decision to proceed with this alternative as an unlined facility was deliberate in that it would allow direct comparison of the environmental effects of an unlined facility at this location—i.e., on a primarily alluvial soil base—versus a fully lined facility at the same Peg Leg location, and also provide an opportunity to evaluate the effects of an unlined facility on alluvium versus an unlined facility at the GPO location, as described in the original GPO Alternative 2 – Proposed Action (since abandoned in favor of detailed analysis of the two GPO Modified Proposed Actions now presented in the DEIS in sections 2.2.4 and 2.2.5).

Under the “Peg Leg – Unlined” alternative, seepage would be controlled through a series of downstream collection embankments and ponds, monitoring wells, and pumpback systems.

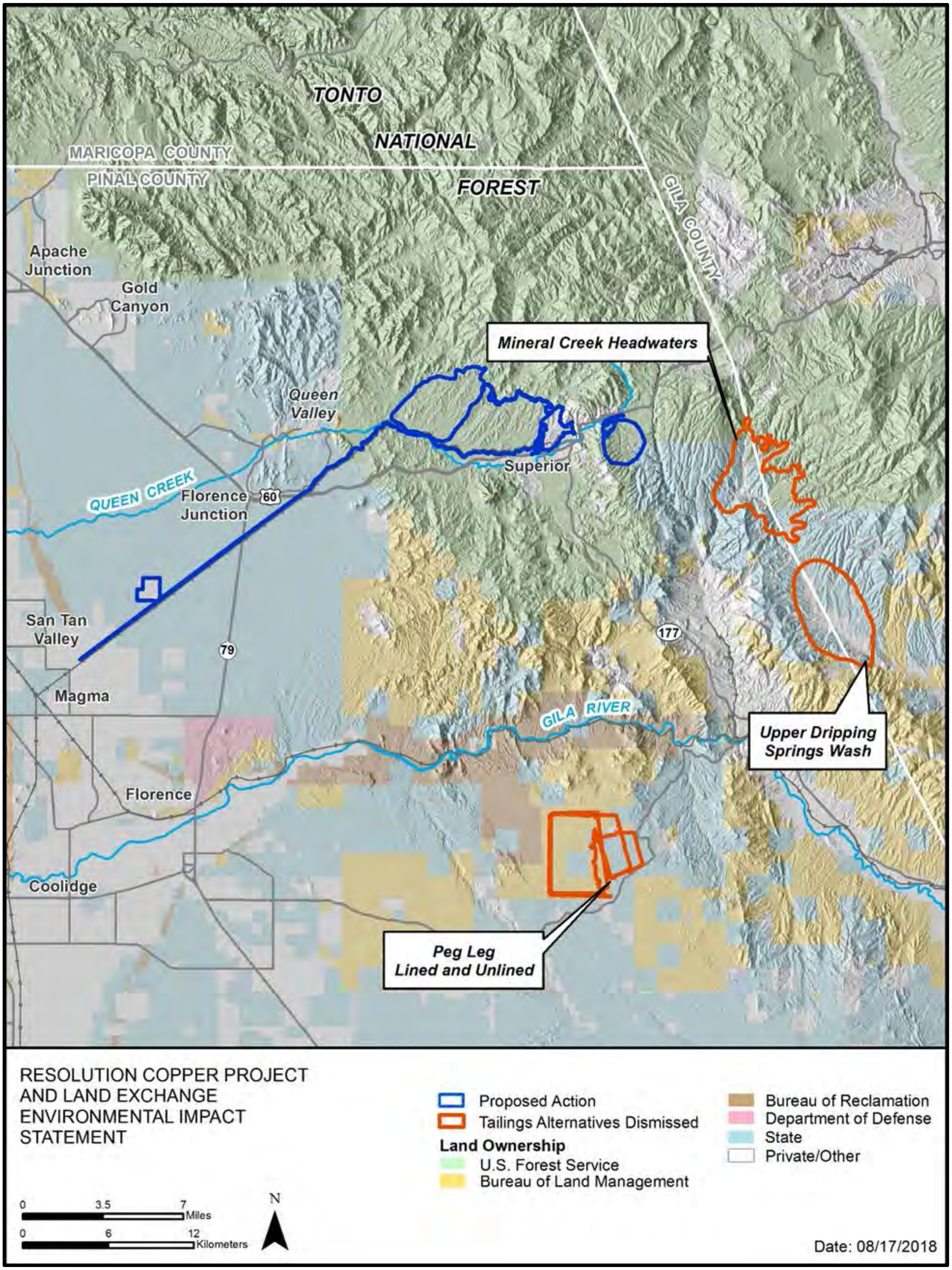

Figure F-2. Alternative tailings facility locations on BLM lands

RATIONALE FOR DISMISSAL FROM DETAILED ANALYSIS OF THE "PEG LEG – LINED" AND "PEG LEG – UNLINED" ALTERNATIVES

After several months of preliminary analysis by Forest Service resource specialists and Resolution Copper technical staff, it was determined that neither the Peg Leg – Lined nor the Peg Leg – Unlined alternatives warranted detailed analysis in the EIS.

Resolution Copper's engineering consultants estimated that generating the huge volumes of earthfill from within the Peg Leg tailings site's footprint in order to construct a downstream embankment would require excavating 0.9 billion tons of soil to a depth up to 160 feet from throughout the roughly 7,000-acre facility—essentially creating a major open-pit aggregate mining operation in addition to the underground mining proposed at the Oak Flat/East Plant Site. Further calculations estimated the effort would require full-time use of more than 140 earthmoving vehicles (dozers, backhoes, haul trucks, etc.), an increase over the amount of equipment needed for other slurry tailings alternatives. The direct carbon dioxide equivalent (CO_{2e}) emissions are 80 to 132 percent higher than the emissions expected at any other alternative embankment types under consideration. The project would have emissions of carbon monoxide (CO), sulfur dioxide (SO_2), nitric oxide (NO), volatile organic compounds (VOCs), and particulate matter (PM_{10} and $PM_{2.5}$). The Tonto National Forest therefore decided to eliminate this alternative because the adverse environmental effects of implementing it were determined to be substantially greater than either the GPO Proposed Action or the other tailings site alternatives already under consideration.

Similarly, the Peg Leg – Unlined alternative was eliminated from further consideration because preliminary analysis had shown the subsurface seepage resulting from having an unlined facility atop an alluvial soil base would be so great as to not be controllable, which would in turn require substantial additional pumping of fresh water to make up the lost seepage.

However, after several months of study, Resolution Copper approached officials at the Tonto National Forest with a proposal for yet a third alternative tailings facility design at the Peg Leg site that combined best practice tailings management aspects from both the Peg Leg lined and unlined alternatives. Their recommended design would shift the entire facility slightly to the east so that the PAG cells could be constructed as a physically separate facility atop a broad outcropping of predominately consolidated rock, retained behind a downstream embankment, while the much greater volume of NPAG tailings would remain on the alluvial base immediately to the west, retained behind a centerline-type embankment. The entire PAG facility would be lined with an engineered low-permeability barrier, while the NPAG facility would be partially lined with an engineered low-permeability liner along the interior, upstream side of the embankment. This design preserves an alternative at the Peg Leg location and incorporates key components of the downstream embankment, centerline embankment, and lining.

This new alternative Peg Leg design has been carried forward for detailed analysis in the DEIS as Alternative 5 – Peg Leg (see section 2.2.7).

In late 2017 and early 2018, meetings between Tonto National Forest managers and BLM managers and resource specialists resulted in two additional tailings storage facility locations being put forth for consideration—neither of which either the Tonto National Forest or Resolution Copper had previously evaluated. These two alternative locations, which were initially referred to as the Mineral Creek Headwaters and Upper Dripping Spring alternatives, are described in greater detail in the following text.

Mineral Creek Headwaters

The BLM identified two general locations in watersheds approximately 7 and 11 miles, respectively, to the southeast of the town of Superior and approximately 3 miles northeast and directly east of the ASARCO Ray Mine as potential tailings sites that the agency believed warranted at least preliminary investigation (see figure F-2).

The first of these, which BLM referred to for planning purposes as the Mineral Creek Headwaters site, is a 6,077-acre area comprising 2.3 acres of BLM-administered public lands, 662 acres of Arizona State Trust surface with Federal mineral estate, 4,304 acres of Arizona State Trust lands with no Federal mineral estate, 80 acres of private surface with Federal mineral estate, and 1,029 acres of private lands with no Federal mineral estate. BLM stated that mining company ASARCO presently holds 21 mining claims within the area. The topography is a steep canyon with smaller side canyons.

Resource specialists and planners at the Tonto National Forest conducted a first-stage screening of the suitability of the Mineral Creek Headwaters area as a site for a future tailings storage facility. Although presumably of sufficient size to store the requisite volume of tailings, the site lies directly atop a perennial reach of Mineral Creek and abundant riparian vegetation. It would also occupy designated critical habitat for Gila chub. For these reasons the Mineral Creek Headwaters site was eliminated from further consideration as a viable alternative for detailed analysis in the EIS.

Upper Dripping Spring Wash

The second potential site identified by the BLM is known as Upper Dripping Spring Wash, a 7,058-acre area directly east of the ASARCO Ray Mine. The site consists of a broad ephemeral wash bounded on the west by the Dripping Spring Mountains and on the east by the Mescal Mountains and the Pinal Mountains, approximately 13 miles north of the confluence of Dripping Spring Wash and the Gila River.

In terms of jurisdiction, the area identified by the BLM comprises 69 acres of BLM-administered public lands, 800 acres of Arizona State Trust surface with Federal mineral estate, 3,762 acres of Arizona State Trust lands with no Federal mineral estate, and 2,427 acres of private lands with no Federal mineral estate. The BLM identified 13 existing mining claims located within the proposed general boundaries of the site. Resolution Copper considered their initial hydrologic and geological assessments of the area highly promising and they engaged their engineering staff and contractors to develop a preliminary design for a tailings facility near this location. The Upper Dripping Spring Wash alternative was eliminated from further consideration as an alternative for detailed analysis in the EIS. However, based on a design for a 3,995-acre tailings impoundment (exclusive of roads, pipeline corridors, and other auxiliary facilities) on only private and Arizona State Trust lands, the Tonto National Forest approved detailed analysis in the DEIS for Alternative 6 and named it “Skunk Camp” for the nearby Skunk Camp Wash. Please see chapter 2 of the DEIS, section 2.2.8.

APPENDIX G. FURTHER DETAILS OF EAST PLANT SITE, WEST PLANT SITE, MARRCO CORRIDOR, AND FILTER PLANT AND LOADOUT FACILITY INFRASTRUCTURE

East Plant Site

Existing East Plant Site Facilities

Several of the existing mine facilities were constructed as part of the Magma Mine, which ceased operations in the mid-1990s, and are either being used by Resolution Copper Mining, LLC (Resolution Copper) to support mineral exploration or are unused legacy facilities. The unused legacy facilities include buildings, cooling towers, a descalant tank, and a wastewater treatment plant. Many of the existing East Plant Site facilities would continue to be used for mining operations and would need to be expanded. Table G-1 identifies the existing East Plant Site facilities and their proposed operations function.

Table G-1. Existing East Plant Site facilities

Facility	Current Function	Proposed Function and/or Changes During Operations
Magma Mine Road	Access to East Plant Site from U.S. Route 60	Access to East Plant Site from U.S. Route 60 (would be realigned at approximately year 8 of operations [mine year 14])
Mine Shaft 9	Supports ongoing installation of Shaft 10	Upcast exhaust shaft
Mine Shaft 10	Under construction, provides development rock for geochemical testing	Upcast exhaust shaft
Decline portal	Provides access to Shaft 10 and ventilation and refrigeration	No functional change
Batch plant	Produces concrete and shotcrete	No functional change; may be expanded, if needed
Electrical and mechanical building	Houses drill core processing and maintenance facilities	No functional change
Compressor building	Houses air compressors and water chillers	No functional change; additional compressor buildings would be constructed near new mine shafts
Water chilling plant	Chills water for Shaft 10	Would be eliminated and replaced by new refrigeration system for downcast Shafts 11, 12, and 13
115-kV Salt River Project (SRP) transmission line	Provides electricity to East Plant Site facilities	Would provide back-up redundancy to the 230-kV SRP transmission lines
115-kV Oak Flat electrical substation	Provides electricity to East Plant Site facilities	Would provide backup power for the underground mining area
Dry facilities	Provides showers, lavatories, and locker facilities for employees and contractors	No functional change; supplemental dry facility would be constructed
General administration building	Offices for mine management, operations, engineering, safety, and environmental personnel	No functional change; would be relocated and expanded
Storage and maintenance facilities	Materials and equipment storage and workshops for equipment maintenance	No functional change; additional storage and equipment maintenance workshops would be constructed
Explosives storage	Storage for explosives in accordance with ATF standards	No functional change; a storage area for surface explosives magazines would be constructed away from the main East Plant Site footprint
Contractor yards	Laydown yards for contractor deliveries	No functional change; laydown yard would be expanded
Chemical storage and containment areas	Containment area for the storage of chemicals	No functional change; chemical storage and containment areas would be located at several of the East Plant Site facilities

Facility	Current Function	Proposed Function and/or Changes During Operations
Water tanks	Two potable water tanks supplying East Plant Site with water delivered by the Never Sweat Tunnel	No functional change; a new mine service water tank would be constructed
Fuel tanks	Storage of fuel	No functional change; additional aboveground and underground fuel tanks would be constructed
Laydown areas	Areas for equipment sorting and stockpiling and materials delivery	No functional change; laydown area locations would change throughout mining phases
Stormwater management	Retention basins for stormwater runoff from impervious areas	No functional change; additional stormwater management facilities would be constructed for expanded East Plant Site footprint
Parking lot	Parking area for employees, contractors, and visitors for approximately 100 vehicles	No functional change; would be relocated and expanded to accommodate approximately 320 vehicles
Security trailer	Controls access to the East Plant Site from Magma Mine Road	No functional change
Public viewing terrace	Terrace overlooking the subsidence area with mine information	Closed to public, mine roads at East Plant Site would be closed to the public
Helicopter pad	Helicopter pad for transporting individuals to advanced medical facilities	No functional change; would be relocated
National Forest System (NFS) Roads	NFS Roads 2432, 2433, 2434, 315, and 469	Segments of these roads that are within the disturbance area and subsidence area would be closed to public access and/or decommissioned.

The Never Sweat Tunnel, an additional existing facility, connects the East Plant Site to the West Plant Site. The Never Sweat Tunnel currently serves two primary functions: (1) the tunnel transports development rock[1] via railcar to the West Plant Site from the underground exploratory development activities at the East Plant Site, and (2) the tunnel transports water to and from the West Plant Site and the East Plant Site. The Never Sweat Tunnel would continue with these functions during mine construction and operations phases.

New East Plant Site Facilities

The primary proposed new mine facilities at the East Plant Site include four additional mine shafts and associated hoisting facilities, the realignment of Magma Mine Road, a wastewater treatment plant, a new Oak Flat substation, the Resolution Copper North substation, and various other facilities (see figure 2.2.2-7). Two new 230-kV power lines, both operated by the Salt River Project (SRP), would be built to support the power demands and to increase the safety and reliability of underground operations.

MINE SHAFTS

Four new mine shafts and associated facilities (hoist houses and a winder house) would be constructed for ore production, hoisting employees in and out of the mine, refrigeration and ventilation purposes, and the construction of mine levels during mine development. Three of the new shafts (Shafts 11, 13, and 14) would be constructed on Resolution Copper–owned land, and one shaft would be constructed on lands currently managed by the Tonto National Forest (Shaft 12) but would be private after the execution of the land exchange.

[1] “Development rock” is rock removed during construction of tunnels and shafts. It may or may not have economic levels of copper. For the most part, development rock is stockpiled and then used during startup of the processing plant.

Table G-2 provides an overview of the six mine shafts that would be used during operations.

Table G-2. Mine shaft overview

Mine Shaft	Surface Ownership	New or Existing	Full Production Phase Function
9	Resolution Copper	Existing (currently being deepened and rehabilitated)	Upcast exhaust shaft
10	Resolution Copper	Existing	Upcast exhaust shaft
11	Resolution Copper	New	Production/downcast fresh air intake
12	Forest Service	New	Production/downcast fresh air intake
13	Resolution Copper	New	Service (employees and equipment)/downcast fresh air intake
14	Resolution Copper	New	Upcast exhaust shaft

MAGMA MINE ROAD REALIGNMENT AND EAST PLANT SITE ROADS

The existing Magma Mine Road is a two-lane paved road that provides access to the East Plant Site from U.S. Route 60. A segment of the existing Magma Mine Road would be located within the anticipated mining subsidence area. At approximately year 8 of mine operations (mine year 14), the segment of the Magma Mine Road within the subsidence area would be relocated outside the subsidence area to the north. The realigned roadway would be a two-lane paved road and would be used by mine employees, contractors, deliveries, and visitors to the mine. The proposed realignment of the Magma Mine Road is depicted in figure 2.2.2-5.

New paved and dirt roads would be constructed within the 133-acre East Plant Site that would connect the various facilities within the site. The roads would not be open for public access and would be used by mine employees and contractors only.

REFRIGERATION PLANT

A primary refrigeration system would be constructed to produce cool air and water for the underground mining operation. This system would consist of a bulk air cooler supplying each downcast shaft, a central refrigeration plant with a service water refrigeration system to provide chilled water, and thermal storage via a chilled water tank. All cooling systems would be equipped by multiple-cell condenser cooling towers for heat rejection.

WASTEWATER TREATMENT PLANT

Sewage from aboveground and underground facilities would be treated at a newly constructed wastewater treatment plant. Sewage from underground mine facilities would be transported to the plant on the surface via a system of pumps. The plant would be an extended aeration biological plant that uses a biological process for treating wastewater and separating the solids from liquid portion of the waste. Designed by the manufacturer, the “packaged plant” would provide treatment to secondary standards as defined by the Arizona Department of Environmental Quality (ADEQ).

ELECTRICAL SUBSTATIONS AND POWER LINES

Two new substations would be constructed at the East Plant Site: the Oak Flat substation and the Resolution Copper North substation and backup. The primary substation for the East Plant Site would be the 230-kV Oak Flat substation, which would be constructed north of the new production shafts to

provide power for aboveground and belowground activities. The substation would be powered by a new 230-kV transmission line originating from the SRP Silver King Substation north of U.S. Route 60.

The North substation and backup would be an alternate power substation and emergency generators would be located next to the production power to provide a backup electricity system. The emergency generators would be capable of backfeeding the main distribution system and would be able to operate the service auxiliary hoist in Shaft 13, partial mine cooling/ventilation system, and other essential services. The emergency generator system would have sufficient capacity to supply the total essential mine load with one of the generators out of service for maintenance.

Two new 230-kV power lines would be built by SRP within a 150-foot corridor with tower heights not typically exceeding 140 feet. Two lines are needed to increase safety and reliability of underground operations. The Silver King to Oak Flat 230-kV transmission main would provide power from the existing Silver King substation north of U.S. Route 60 to the new Oak Flat substation at the East Plant Site. The Superior to Oak Flat 230-kV power line main would provide redundant power from the East Plant Site to the new Superior substation at the West Plant Site.

OTHER NEW EAST PLANT SITE FACILITIES

Other new facilities that would be constructed at the expanded East Plant Site include a wash bay, a standalone first aid building, and a training building. The wash bay would use high-pressure water hoses and oil-water separators to clean vehicles and equipment. Wastewater from the wash bay would be sent to the Never Sweat Tunnel, where it would be combined with East Plant Site contact water and delivered to the West Plant Site process water system. Table G-3 identifies the major consumables, materials, and supplies that would be used at the East Plant Site, their delivered form, and their storage method.

Table G-3. Consumables, materials, and supplies used at East Plant Site

Material/Supply	Delivered Form	Considered Hazardous*	Storage Method
Diesel fuel	Liquid	Yes	Tanks
Propane	Gas	Yes	Tanks
Oils/Lubricants	Liquid	Yes	Sealed drums/totes
Antifreeze	Liquid	Yes	Individual containers
Solvents	Liquid	Yes	Individual containers
Explosives (emulsion product)	Solid	Yes	Locked magazines
Explosives (blasting detonators)	Solid	Yes	Locked magazines
Welding cylinders (argon gas, acetylene, etc.)	Gas	Yes	Cylinder storage corral
Hardware	Solid	No	General stores shelving
Carpentry supplies	Solid	No	General stores shelving

* Potential for physical, chemical, and/or environmental hazard

West Plant Site

Existing West Plant Site Facilities

Currently, the West Plant Site receives development rock from construction of tunnels, shafts, and underground infrastructure at the East Plant Site via the Never Sweat Tunnel. The development rock is sorted at the West Plant Site, tested for mineral composition, and stored at stockpiles. Development rock

is later processed as part of the startup of the concentrator complex. Similar to the East Plant Site, the West Plant Site consists of existing mine facilities constructed during historic mining operations that are either being used by Resolution Copper to support mineral exploration or are unused legacy facilities. The unused legacy facilities include tailings ponds, houses and offices in the upper basin, and the smelter complex. Of these legacy facilities, several have been reclaimed, including the 500-yard waste rock facility, smelter pond, depot pond, Settling Pond 2, and Tailings Pond 5. Several additional legacy facilities at the West Plant Site are currently in the process of being reclaimed, including the smelter facility and Tailings Ponds 6 and 7.

Table G-4 identifies the existing West Plant Site facilities that are currently used for mineral exploration and would continue to be used during mining operations and the facility's proposed function.

Table G-4. Existing West Plant Site facilities

Facility	Current Function	Proposed Function and/or Changes during Operations
Development rock stockpile	Storage of inert NPAG development rock from the East Plant Site for use in construction and reclamation	No functional change; stockpile would expand to a maximum capacity of 10.3 million cubic yards
Intermediate rock stockpiles	Storage of mineralized development rock delivered from the East Plant Site; maximum capacity of up to 774,000 tons or 498,000 cubic yards	No change
Staging areas	Temporary storage of development rock	No functional change; additional staging areas would be constructed near new mine entrance and other facilities
Borrow areas	Aggregate material supply for ongoing closure, redevelopment, and erosion control	No functional change or change in location
General administration building	Offices for mine management, operations, engineering, safety, and environmental personnel	No functional change; a larger additional administration building would be constructed near the new main entrance
Chemical storage facility	Chemicals used in mining activities are stored in Building 203	No functional change; chemical storage and containment areas would be located at several of the West Plant Site facilities
High-density sludge treatment system	Treatment of dewatering water to reduce total dissolved solids, metals, and pH	Dewatering water would be used in the processing cycle
Apex tunnel	Stormwater diversion	No change
Parking lots	Employee, contractor, and visitor parking	New parking areas would be constructed throughout the expanded West Plant Site; new main entrance at Lone Tree; parking for 650 vehicles
Security buildings and gates at access points	Controls access at Main Gate and Lone Tree access points	No functional change; two new security buildings and gates would be constructed: (1) at the relocated main entrance at Main Street and Magma Heights Road, and (2) NFS Road 229 to control access during construction of new substation
Arizona Water Company CAP water tank	500,000-gallon potable water and fire flow supply for West Plant Site and East Plant Site; receives water from a 36-inch water pipeline	No change
Water supply pipelines	Distributes water throughout the West Plant Site and to the mine supply water tank for delivery to East Plant Site via a 16-inch pipeline in the Never Sweat Tunnel	Additional water supply pipelines would be constructed for new and expanded facilities
SRP 115-kV Trask substation	Distribute electricity throughout West Plant Site	Power supplied from the substation would be replaced with a 34.5-kV overhead transmission line to a new 34.5/4.16-kV transformer

Facility	Current Function	Proposed Function and/or Changes during Operations
115-kV SRP transmission line	Electrical supply for West Plant Site	Rerouted to new Superior substation
Stormwater management	Controls and contains stormwater drainage from West Plant Site	Stormwater management system would be expanded to accommodate new and expanded facilities
Laydown yards	Temporary storage for construction deliveries	New laydown yards would be constructed for new and expanded facilities
Private roads	Roads within West Plant Site connecting facilities	New roads would be constructed to connect new and expanded facilities
NFS Road 229 (Silver King Mine Road) and NFS Road 1010	Provides secondary road access to the West Plant Site	NFS Road 229 would be reconstructed between U.S. Route 60 and the West Plant Site to allow for use by construction and mine equipment
Never Sweat Tunnel substation	Provides electricity to Never Sweat Tunnel	No change
Never Sweat Tunnel ventilation	Provides cooling for the Never Sweat Tunnel	No change

New West Plant Site Facilities

The proposed action would expand the West Plant Site from 422 acres to 980 acres to accommodate new facilities. The proposed new mine facilities at the West Plant Site include a new concentrator complex, reconstructed NFS Road 229, new administrative facilities, a water treatment plant, retention and contact water ponds, and electrical substations (see figure 2.2.2-9).

CONCENTRATOR COMPLEX

The concentrator complex at the West Plant Site would employ a traditional sulfide ore processing technique to process up between 132,000 to 165,000 tons of ore per day. The primary structural components of the concentrator complex would be the water process pond, the ore stockpile facility, the grinding circuit, the flotation circuit, and the molybdenum plant.

Process Water Pond and Storage Tank

The process water pond would hold up to 50 million gallons of water for use at the concentrator complex. The pond would be located west of the concentrator complex buildings and be used to pump process water to a 1-million-gallon storage tank at elevation above the concentrator. The tank provides the required head pressure needed at the concentrator. The pond would receive water from a variety of water sources, including Central Arizona Project (CAP) water, return water from the underground mine, and recovered water from the filter plant. The pond would be equipped with emergency overflow and a diversion ditch would be provided to route any potential overflows to a contact water pond south of the concentrator complex. The pond would be constructed so that it is double lined with leak detection and collection in accordance with the ADEQ best available demonstrated control technology requirements. Personnel and wildlife would be protected from entering the pond site with a chain-link fence surrounding the designated area. An emergency overflow containment downstream of the pond located on Resolution Copper property would be required.

Fresh Water Storage Tank

Fresh water would be supplied to the mine from the CAP water canal and wells along the Magma Arizona Railroad Company (MARRCO) corridor. Water is pumped to the West Plant Site along the MARRCO

rail line to a 2-million-gallon CAP water distribution tank. This tank would be located above the concentrator.

Ore Stockpile

Crushed ore from the East Plant Site would be delivered to the West Plant Site via a conveyor system. The conveyor would unload the crushed ore at a covered ore stockpile adjacent to the concentrator complex. The ore stockpile would have a living capacity of 132,000 tons of ore and a total capacity of 441,000 tons. The ore stockpile is a surge facility for the mining operation to allow for short-term shutdowns of either the active mining operations at the East Plant Site or the concentrator operations while the other facility is still in operation.

Grinding Circuit

Ore from the East Plant Site and the ore stockpile would be delivered to the grinding circuit, where the crushed ore would be further ground with water into a slurry before being sent to the flotation circuit. Final grinding circuit design would be determined closer to operations, but according to the General Plan of Operations (GPO) (2016d), the grinding circuit is currently expected to consist of either two semi-autogenous grinding mills and four ball mills or three semi-autogenous mills and six ball mills. Once ore is processed at the semi-autogenous mills and ball mills, the slurry would be distributed to hydrocyclone classifiers (cyclones). Cyclone overflow, the final grinding circuit product, would then be delivered to the flotation circuit for further concentrate processing.

Flotation Circuit

After leaving the grinding circuit, copper and molybdenum would be concentrated in the bulk copper-molybdenum flotation circuit. The flotation circuit would consist of flotation tank cells, a regrind mill, cleaner cells, and copper and molybdenum thickening tanks. Chemical reagents would be used at the thickening tanks to further concentrate the copper and molybdenum and cause it to float to the surface of the slurry where it can be recovered. Chemical reagents would be stored and handled at a separate enclosed reagent building adjacent to the concentrator complex. Recovered molybdenum would be sent to the molybdenum plant at the concentrator complex for further processing. Recovered copper would be sent to the filter plant via the MAARCO corridor for further processing. Tailings—the processed non-economic waste material that results from copper ore processing—would be sent to the tailings storage facility approximately 3 miles west of the West Plant Site via two pipelines. The GPO (2016d) indicates that tailings slurry would be thickened to solids content of approximately 55 to 65 percent. Tailings low in sulfide or pyrite are considered non-potentially acid generating (NPAG). Tailings high in sulfide or pyrite are considered potentially acid generating (PAG). For a list of reagents that would be used in the concentrator complex’s flotation circuit, see GPO table 3.9-3.

Molybdenum Plant

Molybdenum concentrate recovered in the flotation circuit would be further concentrated at the molybdenum plant, where it would be turned into molybdenum filter cake and packaged into sacks or containers. These sacks or containers would be ready for shipment to customers from the molybdenum plant. Approximately four shipments of molybdenum concentrate would be shipped by truck every day from the West Plant Site.

RECONSTRUCTED NFS ROAD 229 (SILVER KING MINE ROAD)

Approximately 1.3 miles of Silver King Mine Road (NFS Road 229) would be reconstructed between U.S. Route 60 and the West Plant Site to provide construction access to the new 230-kV substation. The road would also serve as a secondary access to the West Plant Site that would be designed for use by large construction and mining vehicles and equipment, and would be the main access for large deliveries to and from the West Plant Site.

ADMINISTRATIVE FACILITIES

The existing administrative building would be retained for continued use, and a larger additional administrative building would be constructed near the new main entrance to the West Plant Site. The new administrative building would provide office space for reception, mine management, document control, operations, engineering, safety, and environmental personnel. Space would also be available for conference and safety training rooms, a metallurgical laboratory, a first aid clinic, and dry change house facility.

WATER TREATMENT PLANT

An existing water treatment system is located at the West Plant Site for the treatment water from mine dewatering water at the East Plant Site. Treatment reduces total dissolved solids, metals, and pH prior to delivery to the new Magma Irrigation and Drainage District. During mine operations, water from mine dewatering would be incorporated into the tailings thickener process; however, the water treatment system would remain in place for use as needed.

RETENTION AND CONTACT WATER PONDS

Three new retention and contact water ponds would be constructed to collect and control stormwater flowing from the concentrator and stockpile facilities. The ponds would be located at the foot of the development rock pile and would be designed to collect stormwater for 100-year, 24-hour storm events.

ELECTRICAL SUBSTATIONS AND POWER LINES

A new 230-kV Superior substation would be constructed to provide electricity to West Plant Site facilities. The proposed realignment of Silver King Mine Road would provide access to the new substation during construction. Electricity would be delivered to the new 230-kV substation via a transmission line connection to the existing 230- and 500-kV transmission lines west of the West Plant Site. A redundant electricity supply from the existing Silver King Substation, via the new Oak Flat substation at the East Plant Site, would connect to the new 230-kV substation at the West Plant Site. As needed, several smaller substations would be constructed and connected to the new 230-kV substation to provide electricity to facilities in the West Plant Site.

The existing 115-kV transmission line would be rerouted within the existing West Plant Site boundary to avoid new facilities. A 34.5-kV transmission line would provide power from the West Plant Site along the tailings conveyance corridor to the tailings storage facility. This would power the new facilities at the tailings storage facility.

CONSUMABLES, MATERIALS, AND SUPPLIES USED AT THE WEST PLANT SITE

Table G-5 identifies the major consumables, materials, and supplies that would be used at the West Plant Site, their delivered form, and their storage method. Table G-6 identifies the reagents that would be delivered to, stored, and used at the concentrator complex.

Table G-5. Consumables, materials, and supplies used at the West Plant Site

Material/Supply	Delivered Form	Considered Hazardous*	Storage Method
Diesel fuel	Liquid	Yes	Tanks
Oils/lubricants	Liquid	Yes	Sealed drums/totes
Antifreeze	Liquid	Yes	Individual containers
Solvents	Liquid	Yes	Individual containers
Office supplies	Solid	No	Individual containers
Propane	Gas	Yes	Tanks
Grinding balls	Solid	Yes	Locked magazines
Lab chemicals	Solid	Yes	Locked magazines
Welding cylinders (argon gas, acetylene, etc.)	Gas	Yes	Cylinder storage corral
Hardware	Solid	No	General stores shelving
Carpentry supplies	Solid	No	General stores shelving

* Potential for physical, chemical, and/or environmental hazard

Table G-6. Concentrator complex reagents

Material/Supply	Delivered Form	Considered Hazardous*	Storage Method
Dithiophosphate/monothiosulfate (Cytec 8989; collector) or equivalent copper collector	Bulk truck (liquid)	Yes	Storage tank
Sodium isopropyl xanthate (SIPX; collector)	Drums (dry)	Yes	Drums on pallets
Methyl isobutyl carbinol (MIBC; frother)	Bulk truck (liquid)	Yes	Storage tank
MCO (non-polar flotation oil; molybdenum collector) or #2 Diesel Fuel	Bulk truck (liquid)	Yes	Storage tank
Sodium hydrosulfide (NaHS; copper mineral depressant)	Bulk truck (liquid 30% concentration)	Yes	Storage tank
Flocculant (settling agent)	Bags or super sacks (dry)	Yes	Bags or sacks on pallet
Lime (90% CaO; pH modifier)	Bulk truck (dry)	Yes	Dry storage silos
Antiscalant (water treatment)	Drums (dry) or liquid (totes)	Yes	Drums or totes on pallets
Nitrogen (molybdenum sparge gas)	Vendor or Resolution Copper–owned nitrogen plant	Yes	Nitrogen tank

* Potential for physical, chemical, and/or environmental hazard

MARRCO CORRIDOR

Existing MARRCO Corridor Facilities

The MARRCO corridor is a historic mining railroad corridor that was originally built in the 1920s and ceased operations in the mid-1990s after the closure of the Magma Mine. Several utilities are currently collocated within the MARRCO corridor, including a buried fiber-optic line, an overhead transmission line and telephone line, and buried natural gas pipelines. In addition, the Arizona Water Company maintains a water pipeline and associated facilities within the corridor that supplies the town of Superior with CAP water. More recently, Resolution Copper installed an 18-inch dewatering line within the corridor that delivers treated water from the water treatment plant at the West Plant Site to the new Magma Irrigation and Drainage District. The proposed action would not require these utilities to be relocated or significantly modified.

New MARRCO Corridor Facilities

The proposed action would install several new facilities within or adjacent to the MARRCO corridor. Table G-7 identifies the proposed new facilities in the MARRCO corridor and their function.

Table G-7. New MARRCO corridor facilities

New Facility	Function	Upgrade Needed
CAP water pipeline and associated pump stations and recovery wells	Transport CAP water from CAP canal and recovered filter plant water to West Plant Site through new aboveground 36-inch steel pipeline.	New pump stations would be constructed along corridor to pump CAP water and pressurize pipeline for upgradient delivery to West Plant Site. Locations within the MARRCO corridor between the Queen Creek pump station and West Plant Site would need to be improved by grading and slope stabilization.
Concentrator pipelines	Transport copper concentrate from the West Plant Site to the filter plant and loadout facility through two new 8-inch HDPE-lined steel pipelines.	Grading and slope stabilization would be required at various locations. Depending on site conditions, pipelines would be built aboveground or belowground. The aboveground segments would be located within a containment ditch.
Containment basins	Allow for the emergency storage of concentrate if the pipeline needs to be emptied.	Various locations within the corridor would be excavated and lined with concrete to accommodate upstream volume of concentrate should the pipeline need to be emptied.
Access roads	Provide access to the facilities within the corridor and to the filter plant and loadout facility.	Access roads are described in detail in the Transportation and Access section in chapter 3.
Upgraded rail line and connection to Union Pacific Railroad	Transport copper concentrate from filter plant and loadout facility to the Union Pacific Railroad connection at Magma.	Segment of the rail line between the filter plant and loadout facility and Magma would be upgraded to handle the increase load weight, including an associated upgrade of the rail connection to the Union Pacific Railroad rail line.
Electric lines	Provide electricity to the recovery wells, pump stations, and the filter plant and loadout facility.	Double-circuit 69-kV power lines would be constructed adjacent to the MARRCO corridor to power lines within a new utility easement. The power lines would originate from the Abel substation near the MARRCO corridor's intersection with the CAP canal to the filter plant and loadout facility. A 12-kV power line on the same poles would provide power for the recovery wells within the MARRCO corridor. The power lines would require an additional 50-foot easement adjacent to the northern side of the MARRCO corridor.

FILTER PLANT AND LOADOUT FACILITIES

New Filter Plant and Loadout Facilities

The filter plant (see figure 2.2.2-14) would include a control room, three concentrate stock tanks, up to six concentrate filters, a filtrate clarifier, and compressors. The concentrate would be pumped to the stock tanks and then to the filters. The filtered concentrate would feed via conveyor to the adjacent loadout facility. The filtrate (water) would be separated in the filters and sent to the filtrate clarifier for thickening. Recovered filter water would be sent to a 3-million-gallon water storage tank, where it would mix with CAP water or groundwater before returning to the process water pond at the West Plant Site via a new water supply pipeline within the MARRCO corridor.

The loadout facility (see figure 2.2.2-14) would have a covered stockpile with a capacity of 110,000 tons of concentrate from the filter plant. Concentrate would be loaded into railcars through four hoppers. From the loadout facility, the concentrate would be shipped southwest into Magma Junction, where it would be loaded onto container cars for delivery via the Union Pacific Railroad to an off-site smelter.

As a precautionary measure, a concrete containment basin would also be constructed at the filter plant and loadout facility. The containment basin would allow for the emergency storage of concentrate if the concentrate pipeline in the MARRCO corridor needs to be emptied. The basin would be designed to contain the full volume of both concentrate pipelines.

The filter plant and loadout facility would be accessible from the west by East Skyline Road, east of San Tan Valley, and from the east by State Route 79 and the existing road in the MARRCO corridor. Auxiliary facilities to the filter plant and loadout facility would include a new electrical substation receiving electricity from a transmission line that runs within the MARRCO corridor, a security building, an employee and visitor parking lot, internal roadways, and potable water and wastewater treatment facilities.

CONSUMABLES, MATERIALS, AND SUPPLIES USED AT THE FILTER PLANT AND LOADOUT FACILITY

Table G-8 identifies the major consumables, materials, and supplies that would be used at the filter plant and loadout facility, their delivered form, and their storage method.

Table G-8. Consumables, materials, and supplies used at filter plant and loadout facility

Material/Supply	Delivered Form	Considered Hazardous*	Storage Method
Hardware	Solid	No	General stores shelving
Carpentry supplies	Solid	No	General stores shelving
Office supplies	Solid	No	General stores shelving
Flocculant	Bags or super sacks (dry)	Yes	Bags or sacks on pallets

* Potential for physical, chemical, and/or environmental hazard

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APPENDIX H. FURTHER DETAILS OF MINE WATER BALANCE AND USE

Data Sources

The General Plan of Operations (GPO) describes an initial water budget for the mine, organized by three periods: construction (mine years 1–7), operations (mine years 8–36), and operations rampdown to closure (mine years 37–45) (Resolution Copper 2016d) (GPO figures 3.6-1a–c).

The initial water budget was later reproduced separately for each alternative (WestLand Resources Inc. 2018b). The tables included in this appendix reflect the later alternative water budgets. In some cases, minor differences in amount (within 5 percent) have been ignored for the purposes of simplicity. The water balance for each major mine component (East Plant Site, West Plant Site, filter plant and loadout facility, tailings storage facility, and the makeup water supply from the Desert Wellfield) is described separately.

For the purposes of the draft environmental impact statement (DEIS), a consistent terminology was selected for describing mine phases (Rigg 2017). The alternatives differ from the GPO in that active mining is estimated to only last 40 years, instead of 45 years as described in the GPO. Table H-1 shows the correlation between the various phases from different sources.

Table H-1. Comparison of mine life phases from different water balance data sources

GPO Water Use Phase	GPO Duration	GPO, Translated into EIS Terminology (“Mine Years”)	WestLand 2018 Duration	WestLand 2018 Translated into EIS Terminology (“Mine Years”)
Construction	9 years	Mine years 1–9		
Mine development/rampup	7 years	Mine years 6–12	7 years	Mine years 6–12
Peak mining	29 years	Mine years 13–41	24 years	Mine years 13–36
Mine rampdown	9 years	Mine years 42–50	10 years	Mine years 37–46

Sources: Resolution Copper (2016d), see table 1.8-1 and figures 3.6-1a–c; WestLand Resources Inc. (2018b), see page 1 and figures 1–15

East Plant Site Water Use

Water input at the East Plant Site would come from two major sources: (1) groundwater inflow, and (2) mine service water. All groundwater inflow into the East Plant Site would be pumped in order to dewater the underground mine infrastructure, and sent through a pipeline to be used in the West Plant Site through the Never Sweat Tunnel. The mine service water could consist of fresh water from the Central Arizona Project (CAP) and recovery wells, combined with filtrate return from the filter plant and loadout facility. Mine service water would be delivered from the West Plant Site through a pipeline in the Never Sweat Tunnel.

Water would leave the East Plant Site in four ways: (1) mine dewatering sent to the West Plant Site, (2) as ore moisture, (3) as water lost through the shaft and vent, and (4) as water lost through refrigerant evaporation. Table H-2 identifies the acre-feet per year (AF/year) of water inflow and outflow for the East Plant Site during the construction, operations, and operations rampdown to closure phases.

Table H-2. East Plant Site water inflow and outflow by source per mine phase

	Operations Rampup (Mine Years 6–12)	Peak Operations (Mine Years 13–36)	Operations Rampdown to Closure (Mine Years 37–46)
Inflow Sources			
Groundwater inflow	2,118	1,772	1,298
Mine service water	5,874	6,944	4,081
Total AF/Year	**7,992**	**8,716**	**5,379**
Total AF/Phase	**55,944**	**209,184**	**53,790**
Outflow Sources			
Mine dewatering	4,967	3,992	2,979
Ore moisture	652	1,476	489
Evaporation from shaft, vent, and refrigeration	2,374	3,247	1,911
Total AF/year	**7,993**	**8,715**	**5,379**
Total AF/Phase	**55,951**	**209,160**	**53,790**

West Plant Site Water Use

The water balances for the West Plant Site and the tailings storage facility are closely related, and both change substantially based on the alternative and changes in tailings deposition and location. Water inputs at the West Plant Site that do not vary by alternative include the following: (1) dewatering from East Plant Site, (2) ore moisture, and (3) treated effluent. Water inputs at the West Plant Site that vary based on the tailings facility include the following: (1) process makeup water and (2) reclaimed water from tailings. Process makeup water would be delivered to the West Plant Site from the CAP recovery wells and recycled from the filter plant through a water pipeline in the Magma Arizona Railroad Company (MARRCO) corridor.

Similarly, some components of water leaving the West Plant Site do not vary by alternative and include the following: (1) evaporation and molybdenum plant losses, and (2) concentrate slurry to the filter plant. Water leaving as (3) tailings slurry (non-potentially acid generating [NPAG] and potentially acid generating [PAG] tailings) varies by alternative. Note that for Alternative 4 (filtered tailings), rather than requiring process water for the West Plant Site, an excess of process water is delivered back to the system.

Table H-3 identifies the AF/year of water inflow and outflow for the West Plant Site during the construction, operations, and operations rampdown to closure phases.

Table H-3. West Plant Site water inflow and outflow by source per mine phase

		Operations Rampup (Mine Years 6–12)	Peak Operations (Mine Years 13–36)	Operations Rampdown to Closure (Mine Years 37–46)
Inflow Sources				
East Plant Site dewatering	All alternatives	4,967	3,992	2,979
Ore moisture	All alternatives	652	1,476	489
Treated effluent	All alternatives	36	36	36
Process makeup water	Alternative 2	3,400	13,757	752
Process makeup water	Alternative 3	1,646	10,076	1,592

		Operations Rampup (Mine Years 6–12)	Peak Operations (Mine Years 13–36)	Operations Rampdown to Closure (Mine Years 37–46)
Process makeup water	Alternative 5	1,884	11,074	4,077
Process makeup water	Alternative 6	46	11,779	3,682
Tailings recycled water	Alternative 2	434	2,989	2,365
Tailings recycled water	Alternative 3	2,181	6,670	1,525
Tailings recycled water/collection pond	Alternative 4	7,365	17,017	4,923
Tailings recycled water	Alternative 5	3,850	9,315	1,724
Tailings recycled water	Alternative 6	5,378	8,598	464
Total AF In/Year	Alternative 2	**9,489**	**22,250**	**6,621**
Total AF Inflow/Phase	Alternative 2	**66,423**	**534,000**	**66,210**
Total AF In/Year	Alternative 3	**9,482**	**22,250**	**6,621**
Total AF Inflow/Phase	Alternative 3	**66,374**	**534,000**	**66,210**
Total AF In/Year	Alternative 4	**13,020**	**22,521**	**8,427**
Total AF Inflow/Phase	Alternative 4	**91,140**	**540,504**	**84,270**
Total AF In/Year	Alternative 5	**11,389**	**25,893**	**9,305**
Total AF Inflow/Phase	Alternative 5	**79,723**	**621,432**	**93,050**
Total AF In/Year	Alternative 6	**11,079**	**25,881**	**7,650**
Total AF Inflow/Phase	Alternative 6	**77,553**	**621,144**	**76,500**
Outflow Sources				
Concentrate slurry	All alternatives	416	942	312
Evaporation and molybdenum plant	All alternatives	490	497	488
Tailings slurry (PAG and NPAG)	Alternative 2	8,582	20,810	5,820
Tailings slurry (PAG and NPAG)	Alternative 3	8,575	20,810	5,820
Tailings slurry (PAG and NPAG)	Alternative 4	8,765	20,830	5,650
Tailings slurry (PAG and NPAG) plus makeup water	Alternative 5	10,481	24,454	8,503
Tailings slurry (PAG and NPAG)	Alternative 6	10,172	24,441	6,849
Process water back to system	Alternative 4 only	3,348	251	1,976
Total AF Out/Year	Alternative 2	**9,488**	**22,249**	**6,620**
Total AF Outflow/Phase	Alternative 2	**66,416**	**533,976**	**66,200**
Total AF Out/Year	Alternative 3	**9,481**	**22,249**	**6,620**
Total AF Outflow/Phase	Alternative 3	**66,367**	**533,976**	**66,200**
Total AF Out/Year	Alternative 4	**13,019**	**22,520**	**8,426**
Total AF Outflow/Phase	Alternative 4	**91,133**	**540,480**	**84,260**

		Operations Rampup (Mine Years 6–12)	Peak Operations (Mine Years 13–36)	Operations Rampdown to Closure (Mine Years 37–46)
Total AF Out/Year	Alternative 5	**11,387**	**25,893**	**9,303**
Total AF Outflow/Phase	Alternative 5	**79,709**	**621,432**	**93,030**
Total AF Out/Year	Alternative 6	**11,078**	**25,880**	**7,649**
Total AF Outflow/Phase	Alternative 6	**77,546**	**621,120**	**76,490**

Tailings Storage Facility Water Use

Water input at the tailings storage facility would come from two sources: (1) delivered with tailings (NPAG and PAG) from the West Plant Site, or (2) as captured precipitation and stormwater runoff from the facility or collection ponds.

Water would leave the tailings storage facility in four ways: (1) water reclaimed and sent back to the West Plant Site, (2) water lost through evaporation, (3) water that is entrained with the tailings, and (4) seepage lost to the aquifer. One additional component—change in storage—reflects the fact that the tailings storage facility water balance is dynamic, and during the first two phases more water is coming into the facility than leaving, while during the last phase more water is leaving than coming in.

The inflows for Alternative 4 exceed the outflows by about 8,700 acre-feet during peak operations. This reflects the fact that more water is recovered than can be used. This water may require additional collection, treatment, and disposal.

Tables H-4 through H-8 identify the AF/year of water inflow and outflow for each tailings storage facility alternative during the construction, operations, and operations rampdown to closure phases.

Table H-4. Alternative 2 tailings storage facility water inflow and outflow by source per mine phase

	Operations Rampup (Mine Years 6–12)	Peak Operations (Mine Years 13–36)	Operations Rampdown to Closure (Mine Years 37–46)
Inflow Sources			
Tailings from West Plant Site	8,582	20,810	5,820
Precipitation and stormwater runoff	1,110	1,865	1,625
Change in storage	0	0	543
Total AF In/Year	**9,692**	**22,675**	**7,988**
Total AF Inflow/Phase	**67,844**	**544,200**	**79,980**
Outflow Sources			
Reclaim to West Plant Site	434	2,989	2,365
Evaporation	3,779	9,705	4,853
Entrainment	4,723	9,692	617
Lost seepage	77	153	153
Change in storage	679	136	0
Total AF Out/Year	**9,692**	**22,675**	**7,988**
Total AF Outflow/Phase	**67,844**	**544,200**	**79,880**

Table H-5. Alternative 3 tailings storage facility water inflow and outflow by source per mine phase

	Operations Rampup (Mine Years 6–12)	Peak Operations (Mine Years 13–36)	Operations Rampdown to Closure (Mine Years 37–46)
Inflow Sources			
Tailings from West Plant Site	8,575	20,810	5,820
Precipitation and stormwater runoff	1,007	1,573	1,573
Change in storage	0	0	256
Total AF In/Year	**9,582**	**22,383**	**7,649**
Total AF Inflow/Phase	**67,074**	**537,192**	**76,490**
Outflow Sources			
Reclaim to West Plant Site	2,181	6,670	1,525
Evaporation	2,296	5,270	3,219
Entrainment	4,421	10,259	2,828
Lost seepage	39	77	77
Change in storage	645	107	0
Total AF Out/Year	**9,582**	**22,383**	**7,649**
Total AF Outflow/Phase	**67,074**	**537,192**	**76,490**

Table H-6. Alternative 4 tailings storage facility water inflow and outflow by source per mine phase

	Operations Rampup (Mine Years 6–12)	Peak Operations (Mine Years 13–36)	Operations Rampdown to Closure (Mine Years 37–46)
Inflow Sources			
Tailings from West Plant Site	8,765	20,830	5,650
Precipitation and stormwater runoff	1,298	2,747	3,584
Total AF In/Year	**10,063**	**23,577**	**9,234**
Total AF Inflow/Phase	**70,441**	**565,848**	**92,340**
Outflow Sources			
Reclaim to West Plant Site, including collection ponds	7,562	17,197	5,370
Evaporation	1,414	3,911	3,134
Entrainment	1,021	2,390	651
Lost seepage	66	79	79
Total AF Out/Year	**10,063**	**23,577**	**9,234**
Total AF Outflow/Phase	**70,441**	**565,848**	**92,340**

Table H-7. Alternative 5 tailings storage facility water inflow and outflow by source per mine phase

	Operations Rampup (Mine Years 6–12)	Peak Operations (Mine Years 13–36)	Operations Rampdown to Closure (Mine Years 37–46)
Inflow Sources			
Tailings from West Plant Site (plus makeup water)	10,481	24,454	8,503

	Operations Rampup (Mine Years 6–12)	Peak Operations (Mine Years 13–36)	Operations Rampdown to Closure (Mine Years 37–46)
Precipitation and stormwater runoff	2,819	6,769	9,645
Change in storage	0	0	15
Total AF In/Year	**13,300**	**31,223**	**18,163**
Total AF Inflow/Phase	**93,100**	**749,352**	**181,630**
Outflow Sources			
Reclaim to West Plant Site	3,850	9,315	1,724
Evaporation	3,028	9,929	12,521
Entrainment	4,822	10,335	2,661
Lost seepage	1,218	1,337	1,257
Change in storage	383	308	0
Total AF Out/Year	**13,301**	**31,224**	**18,163**
Total AF Outflow/Phase	**93,107**	**749,376**	**181,630**

Table H-8. Alternative 6 tailings storage facility water inflow and outflow by source per mine phase

	Operations Rampup (Mine Years 6–12)	Peak Operations (Mine Years 13–36)	Operations Rampdown to Closure (Mine Years 37–46)
Inflow Sources			
Tailings from West Plant Site	10,172	24,441	6,849
Precipitation and stormwater runoff	2,589	5,111	6,451
Change in storage	0	0	306
Total AF In/Year	**12,761**	**29,552**	**13,606**
Total AF Inflow/Phase	**89,327**	**709,248**	**136,060**
Outflow Sources			
Reclaim to West Plant Site	5,378	8,598	464
Evaporation	3,221	11,110	9,524
Entrainment	3,600	9,275	2,991
Lost seepage	114	453	627
Change in storage	448	116	0
Total AF Out/Year	**12,761**	**29,552**	**13,606**
Total AF Outflow/Phase	**89,327**	**709,248**	**136,060**

Filter Plant and Loadout Facility Water Use

Water input at the filter plant and loadout facility would come from a single source: as copper thickener underflow delivered from the West Plant Site through the MARRCO corridor.

Water would leave the filter plant and loadout facility in two ways: (1) as filter return water sent back to the West Plant Site and East Plant Site, and (2) as water lost within concentrate.

Table H-9 identifies the AF/year of water inflow and outflow for the filter plant and loadout facility during the construction, operations, and operations rampdown to closure phases.

Table H-9. Filter plant and loadout facility inflow and outflow by source per mine phase

	Operations Rampup (Mine Years 6–12)	Peak Operations (Mine Years 13–36)	Operations Rampdown to Closure (Mine Years 37–46)
Inflow Sources			
Copper thickener underflow	416	942	312
Total AF per Phase	**2,912**	**22,608**	**3,120**
Outflow Sources			
Filter return to West Plant Site and East Plant Site	342	774	257
Concentrate	74	168	56
Total AF/year	**416**	**942**	**313**
Total AF per Phase	**2,912**	**22,608**	**3,130**

Makeup Water Supply from Desert Wellfield

The overall water balances are complex, with the need to account for multiple reclaim/recycle loops and water sources. However, ultimately the mine water supply for each alternative can be reduced to the need for fresh groundwater to be pumped or recovered from the Desert Wellfield, as shown in table H-10. In the event Resolution Copper Mining, LLC, is successful in obtaining a Non-Indian Agriculture Central Arizona Project contract, this could offset groundwater pumping through direct delivery of water; however, this contract has not been approved or completed and therefore CAP water use is not considered in this appendix.

Table H-10. Fresh groundwater supply requirements per mine phase

		Operations Rampup (Mine Years 6–12)	Peak Operations (Mine Years 13–36)	Operations Rampdown to Closure (Mine Years 37–46)	Total Water Use All Phases
Desert Wellfield pumping (AF/year)	Alternative 2	8,932	19,926	4,576	
Total AF per Phase	**Alternative 2**	**62,524**	**478,224**	**45,760**	**586,508**
Desert Wellfield pumping (AF/year)	Alternative 3	7,178	16,245	5,416	
Total AF per Phase	**Alternative 3**	**50,246**	**389,880**	**54,160**	**494,286**
Desert Wellfield pumping (AF/year)	Alternative 4	2,184	5,918	1,848	
Total AF per Phase	**Alternative 4**	**15,288**	**142,032**	**18,480**	**175,800**
Desert Wellfield pumping (AF/year)	Alternative 5	7,416	17,244	7,901	
Total AF per Phase	**Alternative 5**	**51,912**	**413,856**	**79,010**	**544,778**

		Operations Rampup (Mine Years 6–12)	Peak Operations (Mine Years 13–36)	Operations Rampdown to Closure (Mine Years 37–46)	Total Water Use All Phases
Desert Wellfield pumping (AF/year)	Alternative 6	5,578	17,948	7,506	
Total AF per Phase	**Alternative 6**	**39,046**	**430,752**	**75,060**	**544,858**

APPENDIX I. SUMMARY OF EFFECTS OF THE LAND EXCHANGE

COMPARISON OF 36 CFR 228 REGULATIONS WITH OTHER RELATED STATE (ARIZONA) AND FEDERAL ENVIRONMENTAL REGULATIONS

In virtually all cases, some level of regulatory requirements apply to mining operations, regardless of whether they are taking place on private lands or National Forest System lands (see table I-1). U.S. Department of Agriculture Forest Service (herein called Forest Service) Title 36 Code of Federal Regulations (CFR) Part 228 surface management regulations (columns 1 and 2 in the table) apply only to Federal lands administered by the Forest Service. Other applicable laws, regulations, and rules (column 3) apply to both Federal and private lands, except for State mined land reclamation rules which apply only to private lands.

Unless otherwise indicated in the table, surface resource management regulations are taken from 36 CFR 228. Aquifer Protection Permit (APP) laws and regulations are taken from Arizona Revised Statutes (ARS) 49-241 through 49-252 and Arizona Administrative Code (AAC) R18-9-101 through R18-9-403. Arizona State Mine Inspector laws and regulations are taken from Arizona State reclamation statutes at ARS 27-901, et seq., and rules at R11-2-201, et seq. Other regulations and rules are indicated in table I-1.

Table I-1. Comparison of 36 CFR 228 with Other Applicable Laws, Statutes, Regulations, and Rules

Forest Service Regulations 36 CFR 228 Subpart A – Locatable Minerals	Description	Other Applicable Laws, Statutes, Regulations, and Rules that are comparable to 36 CFR 228 Subpart A – Locatable Minerals
36 CFR 228.4	*Description of Operations.* In a notice of intent submitted to the appropriate District Ranger, sufficient description of the proposed area of activity, route(s) of access, equipment, devices, or practices proposed for use during operations including, where applicable—	None
36 CFR 228.4(c)(2) 36 CFR 228.4(c)(3)	A map or sketch showing information sufficient to locate the proposed area of operations on the ground, existing and/or proposed roads or access routes to be used in connection with the operations as set forth in §228.12, and the approximate location and size of areas where surface resources will be disturbed. Information sufficient to describe or identify the type of operations proposed and how they would be conducted, the type and standard of existing and proposed roads or access routes, the means of transportation used or to be used as set forth in §228.12, the period during which the proposed activity will take place, and measures to be taken to meet the requirements for environmental protection in §228.8.	APP R18-9-A.202.A Technical Requirements Mined Land Reclamation R11-2-501. Mining unit reclamation plan content. Clean Water Act 33 CFR 320 through 332 40 CFR 122
36 CFR 228.8(a)	*Air quality.* Operator shall comply with applicable Federal and State air quality standards, including the requirements of the Clean Air Act, as amended (42 USC 1857 et seq.).	Clean Air Act: Certification by ADEQ; ARS 49-401 et seq.; R18-2-101 et seq.
36 CFR 228.8(b)	*Water quality.* Operator shall comply with applicable Federal and State water quality standards, including regulations issued pursuant to the Federal Water Pollution Control Act, as amended (33 U.S.C. 1151 et seq.).	APP R18-9-A.202.A Technical Requirements Clean Water Act 33 CFR 320 through 332 40 CFR 122 AZPDES (Arizona delegated program) R18-9-B901 et seq.

Forest Service Regulations 36 CFR 228 Subpart A – Locatable Minerals	Description	Other Applicable Laws, Statutes, Regulations, and Rules that are comparable to 36 CFR 228 Subpart A – Locatable Minerals
36 CFR 228.8(c)	*Solid wastes*. Operator shall comply with applicable Federal and State standards for the disposal and treatment of solid wastes. All garbage, refuse, or waste, shall either be removed from National Forest lands or disposed of or treated so as to minimize, so far as is practicable, its impact on the environment and the forest surface resources. All tailings, dumpage, deleterious materials, or substances and other waste produced by operations shall be deployed, arranged, disposed of, or treated so as to minimize adverse impact upon the environment and forest surface resources.	APP R18-9-A.202.A Technical Requirements Clean Water Act 33 CFR 320 through 332 40 CFR 122 AZPDES (Arizona delegated program) R18-9-B901 et seq.
36 CFR 228.8(d)	*Scenic values.* Operator shall, to the extent practicable, harmonize operations with scenic values through such measures as the design and location of operating facilities, including roads and other means of access, vegetative screening of operations, and construction of structures and improvements which blend with the landscape.	None [On most public lands there are no State or other Federal requirements for the protection of scenic values that are comparable to 36 CFR 228.8(d). However, lands having special management designations, such as Wilderness, National Monument, Wild and Scenic River, State Park, and the like are usually bound by particular restrictions on human development and other activities that would tend to alter natural scenic values.]
36 CFR 228.8(e)	*Fisheries and wildlife habitat.* In addition to compliance with water quality and solid waste disposal standards required by this section, operator shall take all practicable measures to maintain and protect fisheries and wildlife habitat which may be affected by the operations.	ARS 27-971. Submission and contents of reclamation plan.
36 CFR 228.8(f)	*Roads.* Operator shall construct and maintain all roads so as to assure adequate drainage and to minimize or, where practicable, eliminate damage to soil, water, and other resource values. Unless otherwise approved by the authorized officer, roads no longer needed for operations: (1) Shall be closed to normal vehicular traffic, (2) Bridges and culverts shall be removed, (3) Cross drains, dips, or water bars shall be constructed, and (4) The road surface shall be shaped to as near a natural contour as practicable and be stabilized.	Mined Land Reclamation R11-2-603. Mining unit reclamation plan content.
36 CFR 228.8(g)	*Reclamation.* Upon exhaustion of the mineral deposit or at the earliest practicable time during operations, or within 1 year of the conclusion of operations, unless a longer time is allowed by the authorized officer, operator shall, where practicable, reclaim the surface disturbed in operations by taking such measures as will prevent or control on-site and off-site damage to the environment and forest surface resources including: (1) Control of erosion and landslides; (2) Control of water runoff; (3) Isolation, removal or control of toxic materials; (4) Reshaping and revegetation of disturbed areas, where reasonably practicable; and (5) Rehabilitation of fisheries and wildlife habitat.	Mined Land Reclamation R11-2-201 through R11-2-207 General regulatory provisions for plan documents. Mined Land Reclamation R11-2-602. Erosion control and topographic contouring.

Forest Service Regulations 36 CFR 228 Subpart A – Locatable Minerals	Description	Other Applicable Laws, Statutes, Regulations, and Rules that are comparable to 36 CFR 228 Subpart A – Locatable Minerals
36 CFR 228.9	*Maintenance during operations, public safety.* During all operations, operator shall maintain his structures, equipment, and other facilities in a safe, neat, and workmanlike manner. Hazardous sites or conditions resulting from operations shall be marked by signs, fenced, or otherwise identified to protect the public in accordance with Federal and State laws and regulations.	Mined Land Reclamation R11-2-601. Public safety standards. ARS 27-318. State requirements to cover, fence, fill, or otherwise secure areas around active or inactive/abandoned mining operations and to post warning signs.
36 CFR 228.10	*Cessation of operations, removal of structures and equipment.* Unless otherwise agreed to by the authorized officer, operator shall remove within a reasonable time following cessation of operations all structures, equipment, and other facilities and clean up the site of operations. Other than seasonally, where operations have ceased temporarily, an operator shall file a statement with the District Ranger which includes: (a) Verification of intent to maintain the structures, equipment and other facilities, (b) The expected reopening date, and (c) An estimate of extended duration of operations. A statement shall be filed every year in the event operations are not reactivated. Operator shall maintain the operating site, structures, equipment, and other facilities in a neat and safe condition during nonoperating periods.	Mined Land Reclamation ARS 27-971. Submission and contents of reclamation plan. R11-2-501. Mining unit reclamation plan content.
36 CFR 228.11	*Prevention and control of fire.* Operator shall comply with all applicable Federal and State fire laws and regulations and shall take all reasonable measures to prevent and suppress fires on the area of operations and shall require his employees, contractors, and subcontractors to do likewise.	Mined Land Reclamation ARS 27-311. Fire prevention and protection.
36 CFR 228.12	*Access*. An operator is entitled to access in connection with operations, but no road, trail, bridge, landing area for aircraft, or the like, shall be constructed or improved, nor shall any other means of access, including but not limited to off-road vehicles, be used until the operator has received approval of an operating plan in writing from the authorized officer when required by §228.4(a). Proposals for construction, improvement, or use of such access as part of a plan of operations shall include a description of the type and standard of the proposed means of access, a map showing the proposed route of access, and a description of the means of transportation to be used. Approval of the means of such access as part of a plan of operations shall specify the location of the access route, design standards, means of transportation, and other conditions reasonably necessary to protect the environment and forest surface resources, including measures to protect scenic values and to ensure against erosion and water or air pollution.	Mined Land Reclamation R11-2-501. Mining unit reclamation plan content. R11-2-603. Roads.

Forest Service Regulations 36 CFR 228 Subpart A – Locatable Minerals	Description	Other Applicable Laws, Statutes, Regulations, and Rules that are comparable to 36 CFR 228 Subpart A – Locatable Minerals
36 CFR 228.13	*Bonds.* (a) Any operator required to file a plan of operations shall, when required by the authorized officer, furnish a bond conditioned upon compliance with §228.8(g), prior to approval of such plan of operations. In lieu of a bond, the operator may deposit into a Federal depository, as directed by the Forest Service, and maintain therein, cash in an amount equal to the required dollar amount of the bond or negotiable securities of the United States having market value at the time of deposit of not less than the required dollar amount of the bond. A blanket bond covering nationwide or statewide operations may be furnished if the terms and conditions thereof are sufficient to comply with the regulations in this part. (b) In determining the amount of the bond, consideration will be given to the estimated cost of stabilizing, rehabilitating, and reclaiming the area of operations. (c) In the event that an approved plan of operations is modified in accordance with §228.4 (d) and (e), the authorized officer will review the initial bond for adequacy and, if necessary, will adjust the bond to conform to the operations plan as modified. (d) When reclamation has been completed in accordance with §228.8(g), the authorized officer will notify the operator that performance under the bond has been completed, provided, however, that when the Forest Service has accepted as completed any portion of the reclamation, the authorized officer shall notify the operator of such acceptance and reduce proportionally the amount of bond thereafter to be required with respect to the remaining reclamation.	Mined Land Reclamation ARS 27-991 through 27-997. Financial assurance. R11-2-801 through R11-2-822. Financial assurance.
36 CFR 228.14	*Appeals.* Any operator aggrieved by a decision of the authorized officer in connection with the regulations in this part (i.e., 36 CFR part 228) may file an appeal under the provisions of 36 CFR part 251, subpart C.	Mined Land Reclamation ARS 27-933. Denials; appeals.

Abbreviations: ADEQ = Arizona Department of Environmental Quality, APP = Aquifer Protection Permit, ARS = Arizona Revised Statutes, AZPDES = Arizona Pollutant Discharge Elimination System, CFR = Code of Federal Regulations, R = Arizona Administrative Code Rule.

APPENDIX J. MITIGATION AND MONITORING PLAN

Introduction

This mitigation and monitoring plan has been developed by the Tonto National Forest using information from a number of sources. As stated in section 2.3 of the environmental impact statement (EIS), the Council on Environmental Quality states that agencies should not commit to mitigation measures absent the authority or expectation of necessary resources to ensure the mitigation is performed (Council on Environmental Quality 2011). This mitigation and monitoring plan is designed to clearly disclose which mitigation and monitoring items are within the authority of the U.S. Department of Agriculture Forest Service (Forest Service) or other regulatory permitting agency (e.g., U.S. Army Corps of Engineers, Bureau of Land Management [BLM], Arizona Department of Environmental Quality, or Arizona Department of Water Resources).

This appendix discusses the following items:

- Design Features and Applicant-Committed Environmental Protection Measures
- Mitigation and Monitoring Measures Considered in Chapter 3 Impacts Analysis
- Other Mitigation and Monitoring Measures Not Considered in Chapter 3 Impacts Analysis

Design Features and Applicant-Committed Environmental Protection Measures

The environmental analysis considered for this EIS includes the implementation of Applicant-Committed Environmental Protection Measures. These measures are listed in each resource section of chapter 3 in a section titled: “Summary of Applicant-Committed Environmental Protection Measures.” Applicant-Committed Environmental Protection Measures are features incorporated into the design of the project by Resolution Copper Mining, LLC (Resolution Copper) to reduce potential impacts on resources. These measures would be non-discretionary as they are included in the project design, and their effects are accounted for in the analysis of environmental consequences disclosed in each resource section of chapter 3.

Many of these features are either specified in the General Plan of Operations (GPO) or were developed as part of the action alternatives. Resolution Copper has created the following plans to detail the protection measures they will employ under the action alternatives:

- Subsidence management plan (appendix to GPO; also updated in May 2018 in response to the Geology and Subsidence Workgroup [Tshishens 2018a])
- Groundwater mitigation and monitoring plan (created in April 2019 in response to the Groundwater Modeling Workgroup [Montgomery & Associates 2019])
- Road use plan—updating for tailings storage facility alternatives (appendix to GPO)
- Environmental emergency and response and contingency plan (appendix to GPO)
- Fire prevention and response plan (appendix to GPO)
- Preliminary spill prevention control and countermeasures plan (SPCC) (appendix to GPO)
- Explosives management plan (appendix to GPO)
- Acid rock drainage management plan (appendix to GPO)

- Hydrocarbon management plan (appendix to GPO)
- Environmental materials management plan (appendix to GPO)
- Preliminary stormwater pollution prevention plan (SWPPP) (appendix to GPO)
- Wildlife management plan (appendix to GPO)
- Noxious weed and invasive species plan (created May 2019 in response to EIS analysis [Resolution Copper 2019])
- Historic properties treatment plan, Oak Flat land exchange parcel (currently under development as part of tribal consultation and Section 106 consultation)
- Historic properties treatment plan for GPO (currently under development as part of tribal consultation and Section 106 consultation)
- Tailings Pipeline Management Plan (AMEC Foster Wheeler Americas Limited 2019)
- Concentrate Pipeline Management Plan (M3 Engineering and Technology Corporation 2019)

The implementation and effectiveness of Applicant-Committed Environmental Protection Measures are considered integral to the analysis considered in this EIS. These design features would be a requirement of the final Record of Decision (ROD) and final mining plan of operations. As these measures are considered part of the proposed project, they are not reiterated in this appendix.

Mitigation and Monitoring Measures Considered in Chapter 3 Impacts Analysis

Mitigation and Monitoring Required by Forest Service

The role of the Tonto National Forest under its primary authorities in the Organic Administration Act, Locatable Regulations (36 Code of Federal Regulations [CFR] 228 Subpart A), and Multiple-Use Mining Act is to ensure that mining activities minimize adverse environmental effects on National Forest System (NFS) surface resources. The Forest Service authority related to mitigation is limited to protection of surface resources of NFS lands (see 30 United States Code [U.S.C.] 612, 5 U.S.C. 551, and 36 CFR 228.1).

In order for the Forest Service to require implementation of mitigation, the mitigation must have a direct connection to avoiding, mitigating, or minimizing effects on NFS surface resources. The Forest Service has no authority, obligation, or expertise to determine or enforce compliance with other agencies' laws or regulations. However, it is the operator's responsibility to ensure that its actions comply with applicable laws. The Forest Service will only approve a final plan of operations once all other necessary permits are approved.

Mitigation and monitoring items under this heading are within the authority of the Forest Service, the U.S. Fish and Wildlife Service through the Biological Opinion resulting from consultation under Section 7 of the Endangered Species Act, or the Arizona State Historic Preservation Office (SHPO) through the current programmatic agreement (PA) and associated historic properties treatment plan (HPTP). These measures would be specified as a requirement of the final ROD and incorporated into the final mining plan of operations. The Forest Service is responsible for determining whether the implementation of mitigation and the results of monitoring in this category are in compliance with the decision that will be

documented in the final ROD and final mining plan of operations, and it has a legal obligation to ensure that the requirements of the biological opinion and PA/HPTP are implemented. Resolution Copper would submit reports to the Tonto National Forest for review of work done in the previous year and be subject to routine inspections to verify mitigation and monitoring effectiveness.

Mitigation and Monitoring Agreed to by Resolution Copper Mining, LLC

Resolution Copper has publicly agreed to implement the mitigation and monitoring items under this heading. These include contractual, financial, and other agreements over which the Forest Service and other regulatory agencies have no jurisdiction. The Forest Service and regulatory agencies have no authority, obligation, or expertise to determine or enforce compliance of the measures included in this category. They are presented here to facilitate disclosure of currently known mitigation and monitoring and their consideration in impacts analyses.

These measures differ from the Applicant-Committed Environmental Protection Measures in that they were not proposed as part of the project or alternatives and in many cases were developed directly in response to the EIS analysis in order to reduce resource impacts. Since the Forest Service and regulatory permitting agencies cannot require implementation of the mitigation and monitoring measures in this category, their implementation is not assured. The effectiveness of these mitigation measures is included in chapter 3 of the EIS. At the current point in the National Environmental Policy Act (NEPA) process, it is recognized that these are measures that may occur, as opposed to measures that would occur. However, once these measures are included in the signed Final ROD and final mining plan of operations, they would be legally binding on Resolution Copper.

Reporting and Evaluation

Monitoring would be evaluated annually after reports are reviewed by the appropriate land-managing agency to determine whether the level of monitoring and/or reporting is appropriate for the current conditions. This review may result in a change in the monitoring requirements. Please refer to section 2.3 of the EIS for a discussion of mitigation-related monitoring and evaluation.

Detail of Mitigation and Monitoring Measures Analyzed in Chapter 3 Impacts Analysis

At this time, the mitigation and monitoring measures analyzed are conceptual in nature. The following information is included, with additional implementation details to be developed prior to the Record of Decision:

- Unique identification number
- Title of mitigation/monitoring measure
- Description/overview of measure
- Source of measure
- Resource affected/impacts being mitigated
- Alternatives to which the measure is applicable

Geology, Minerals, Subsidence (1 measure)

FS-222: Subsidence Monitoring Plan
Description/overview: The subsidence monitoring plan proposed by Resolution Copper has been included in the EIS as an Applicant-Committed Environmental Protection Measure, however, as subsidence has the potential to impact Tonto National Forest surface resources, the Forest Service will require that a final subsidence monitoring plan be completed and approved by the Forest Service prior to signing a decision.
Source of measure: The preliminary subsidence monitoring plan is included by Resolution Copper as an Applicant-Committed Environmental Protection Measure. The requirement for a final subsidence monitoring plan was identified by the Forest Service as a required mitigation measure.
Resource affected/impacts being mitigated: This statement seeks to mitigate impacts of subsidence on Forest Service surface resources, including the Apache Leap Special Management Area.
Applicable alternatives: All
Authority to require: As subsidence would impact Forest Service surface resources, authority exists under 36 CFR 228.8.
Additional ground disturbance: No additional ground disturbance anticipated.

Soils and Vegetation (5 measures)

RC-208: Salvage of select vegetation and trees within the Tailings Storage Facility footprint
Description/overview: To the extent practicable, Resolution Copper will salvage select vegetation and select suitable trees within the tailings storage facility footprint.
Source of measure: Resolution Copper
Resource affected/impacts being mitigated: This statement seeks to mitigate impacts on vegetation by directly salvaging individual plants, but also through improving reclamation success and recovery of habitat after closure.
Applicable alternatives: All
Authority to require: As an applicant-proposed measure, implementation is not assured; however, once this measure is included in the ROD/Final mining plan of operations it would be required by the Forest Service.
Additional ground disturbance: While this would require ground disturbance, it would be within the existing area of analysis of the project fence line.

FS-223: Conduct soil surveys within the area to be disturbed by the Preferred Alternative Tailings Storage Facility footprint
Description/overview: While adequate soil and vegetation information exists to conduct an assessment for the purposes of disclosing impacts under NEPA and comparing between alternatives, the level of information may not be sufficient to support detailed final reclamation plans and a final mining plan of operations. To support these documents, soil surveys need to be conducted within the disturbance footprint of the Preferred Alternative tailings storage facility. The specific purpose of the surveys would be identify general soil characteristics, estimate the amount of soil or unconsolidated material that would be available for salvage to support reclamation activities, and inform the ability of salvaged material to support reclamation efforts. The appropriate level of detail for the soil survey would be determined in conjunction with the Tonto National Forest. The Forest Service is requiring that these surveys be conducted between the draft EIS (DEIS) and final EIS (FEIS).
Source of measure: Forest Service
Resource affected/impacts being mitigated: This statement seeks to mitigate impacts on long-term reclamation and vegetation.
Applicable alternatives: Preferred Alternative
Authority to require: While the footprint of the Preferred Alternative may not involve Forest Service surface resources, other aspects of the project still involve Forest Service surface resources, and the information collected under this measure is considered necessary for the development of reclamation plans supporting the final mining plan of operations.
Additional ground disturbance: While this would require ground disturbance, it would be within the existing area of analysis of the project fence line.

FS-224: Conduct appropriate testing of soil materials within the Preferred Alternative Tailings Storage Facility footprint
Description/overview: Similarly, in order to support detailed final reclamation plans and a final mining plan of operations, appropriate testing would be conducted on soil samples collected from within the Preferred Alternative footprint. These tests could include such parameters as soil organic carbon, moisture capacity, nutrients, pH/acidity/alkalinity. Tests would also include those appropriate to estimate post-closure water quality of stormwater runoff interacting with the salvaged soil. The appropriate suite of tests to be conducted would be determined in conjunction with the Tonto National Forest. The Forest Service is requiring that these tests be conducted between the DEIS and FEIS.
Source of measure: Forest Service
Resource affected/impacts being mitigated: This statement seeks to mitigate impacts on long-term reclamation and vegetation.
Applicable alternatives: Preferred Alternative

Authority to require: While the footprint of the Preferred Alternative may not involve Forest Service surface resources, other aspects of the project still involve Forest Service surface resources, and the information collected under this measure is considered necessary for the development of reclamation plans supporting the final mining plan of operations.
Additional ground disturbance: While this would require ground disturbance, it would be within the existing area of analysis of the project fence line.

FS-225: Conduct vegetation surveys within the Preferred Alternative Tailings Storage Facility footprint
Description/overview: In order to support detailed final reclamation plans and a final mining plan of operations, vegetation surveys need to be conducted within the disturbance footprint of the Preferred Alternative tailings storage facility. These surveys would identify general vegetation present, density, abundance of native/non-native species, and any special status plant species for which site characteristics are appropriate for occurrence. The appropriate level of detail for these surveys would be determined in conjunction with the Tonto National Forest. The Forest Service is requiring that these surveys be conducted between the DEIS and FEIS.
Source of measure: Forest Service
Resource affected/impacts being mitigated: This statement seeks to mitigate impacts on long-term reclamation and vegetation.
Applicable alternatives: Preferred Alternative
Authority to require: While the footprint of the Preferred Alternative may not involve Forest Service surface resources, other aspects of the project still involve Forest Service surface resources, and the information collected under this measure is considered necessary for the development of reclamation plans supporting the final mining plan of operations.
Additional ground disturbance: No ground disturbance anticipated.

FS-226: Preparation of detailed reclamation plans for the Preferred Alternative

Description/overview:
Information derived from the soil surveys, vegetation surveys, and soil testing would be used to develop detailed reclamation plans for the Preferred Alternative. These reclamation plans would be more specific than those included in the GPO, and would include such details as: maps of the post-closure landform depicting the type of final closure cover for each area (depth of material, type of material, anticipated source of material and preparation methods like crushing or sorting, and need for/presence of armoring); anticipated reclamation techniques such as surface preparation, seeding, planting, watering (if any), soil amendments; soil salvage storage locations and storage management techniques; maps of the post-closure landform or the landform over time, depicting phasing of revegetation or reclamation activities; monitoring details including proposed success criteria and the potential use of comparison reference plots. The detailed reclamation plans would also include more specific information on post-closure stormwater controls, the anticipated longevity of engineered control systems, and criteria for when stormwater would be deemed appropriate for release back to the downstream drainages. The appropriate level of detail for the final reclamation plans would be determined in conjunction with the Tonto National Forest. The Forest Service is requiring that these plans be prepared between the DEIS and FEIS.

Source of measure:
Forest Service

Resource affected/impacts being mitigated:
This statement seeks to mitigate impacts on long-term reclamation and vegetation.

Applicable alternatives:
Preferred Alternative

Authority to require:
While the footprint of the Preferred Alternative may not involve Forest Service surface resources, other aspects of the project still involve Forest Service surface resources, and the information collected under this measure is considered necessary to support the final mining plan of operations.

Additional ground disturbance:
No additional ground disturbance anticipated.

Noise and Vibration (1 measure)

RC-218: Alternate road access to Skunk Camp Tailings Storage Facility

Description/overview:
Alternate access to Skunk Camp tailings storage facility to reduce noise impacts on residences along Dripping Springs Road. Two road corridors have been proposed and are shown in Attachment 2. Initial corridors are based on a 1,000-foot right-of-way (ROW), but road width would likely be smaller or the corridor could be changed based on ground surveys. Cultural and biological surveys would be required as well as consultation with the adjacent landowners or land-managing agencies.

Source of measure:
Resolution Copper

Resource affected/impacts being mitigated:
This statement seeks to mitigate impacts from noise, dust, and traffic along Dripping Springs Road.

Applicable alternatives:
Alternative 6 only

Authority to require: As an applicant-proposed measure, implementation is not assured; however, once this measure is included in the ROD/Final mining plan of operations it would be required by the Forest Service.
Additional ground disturbance: Yes. The shorter road would include 364 acres based on 1,000-foot ROW for construction and 3.12 miles in length. The longer road would include 1,391 acres based on 1,000-foot ROW for construction and 11.92 miles in length.

Transportation and Access (none)

Air Quality (none)

Water Resources (1 measure)

RC-211: Seeps and Spring Monitoring and Mitigation Plan (GDE plan)
Description/overview: In April 2019, the Forest Service received from Resolution Copper a document titled “Monitoring and Mitigation Plan for Groundwater Dependent Ecosystems and Water Wells” (Montgomery and Associates Inc. 2019). This document outlines monitoring plan to assess potential impacts on each groundwater-dependent ecosystem (GDE), identifies triggers and associated actions to be taken by Resolution Copper to ensure that GDEs are preserved, and suggested mitigation measures for each GDE if it is shown to be impacted by future mine dewatering. Note that this plan includes actions both for GDEs and water supply wells. The plan focuses on the same GDEs described in this section of the EIS, as these are the GDEs that are believed to rely on regional groundwater that could be impacted by the mine. The stated goal of the plan is “to ensure that groundwater supported flow that is lost due to mining activity is replaced and continues to be available to the ecosystem.” The plan specifically notes that it is not intended to address water sources associated with perched shallow groundwater in alluvium or fractures. The specific GDEs addressed by this plan include • Bitter, Bored, Hidden, Iberri, Kane, McGinnel, McGinnel Mine, No Name, Rock Horizontal, and Walker Springs; • Queen Creek below Superior (reach km 17.39 to 15.55) and at Whitlow Ranch Dam; • Arnett Creek in two locations; • Telegraph Canyon in two locations; • Devil’s Canyon springs (DC4.1E, DC6.1E, DC6.6W, and DC8.2W) • Devil’s Canyon surface water in two locations (reach km 9.1 to 7.5, and reach km 6.1 to 5.4) • Mineral Creek springs (Government Springs, MC3.4W) • Mineral Creek surface water in two locations (MC8.4C, and reach km 6.9 to 1.6) Monitoring frequency and parameters are discussed in the plan, and include such things as groundwater level or pressure, surface water level, presence of water or flow, extent of saturated reach, and phreatophyte area. In general, groundwater level or pressure and surface water level would be monitored daily (using automated equipment), while other methods would be monitored quarterly or annually.

Water supplies to be monitored are Superior (using well DHRES-16_743 as a proxy), Boyce Thompson Arboretum (using the Gallery Well as a proxy), and Top-of-the-World (using HRES-06 as a proxy). A variety of potential actions are identified that could be used to replace water sources if monitoring reaches a specified trigger. Specific details (likely sources and pipeline corridor routes) are shown in the plan. These include the following: • Drilling new wells, applicable to both water supplies and GDEs. The intent of installing a well for a GDE is to pump supplemental groundwater that can be used to augment flow. The exact location and construction of the well would vary; it is assumed in many cases groundwater would be transported to GDEs via an overland pipeline to minimize ground disturbance. Wells require maintenance in perpetuity, and likely would be equipped with storage tanks and solar panels, depending on specific site needs. • Installing spring boxes. These are structures installed into a slope at the discharge point of an existing spring, designed to capture natural flow. The natural flow is stored in a box and discharged through a pipe. Spring boxes can be deepened to maintain access to water if the water level decreases. Spring boxes require little ongoing maintenance to operate. • Installing guzzlers. Guzzlers are systems for harvesting rainwater for wildlife consumption. Guzzlers use an impermeable apron, typically installed on a slope, to collect rainwater which is then piped to a storage tank. A drinker allows wildlife and/or livestock to access water without trampling or further degrading the spring or water feature. Guzzlers require little ongoing maintenance to operate. • Installing surface water capture systems such as check dams, alluvial capture, recharge wells, or surface water diversions. All of these can be used to supplement diminished groundwater flow at GDEs by retaining precipitation in the form of runoff or snowmelt, making it available for ecosystem requirements. • Providing alternative water supplies from a non-local source. This would be considered only if no other water supply is available, with Arizona Water Company or the Desert Wellfield being likely sources of water.
Source of measure: Resolution Copper
Resource affected/impacts being mitigated: This statement seeks to mitigate impacts on water resources.
Applicable alternatives: All
Authority to require: As an applicant-proposed measure, implementation is not assured; however, once this measure is included in the ROD/Final mining plan of operations it would be required by the Forest Service. As some GDEs impacted are Forest Service surface resources, authority exists under 36 CFR 228.8 for part of this measure.
Additional ground disturbance: Yes, quantified in Seeps and Springs Plan

Wildlife (6 measures)

GP-125: Follow AGFD and FWS guidance for mitigation of impacts on wildlife
Description/overview: Follow guidance from the Arizona Game and Fish Department (AGFD) and U.S. Fish and Wildlife Service (FWS) regarding avoidance, minimization, and mitigation measures for wildlife. The AGFD's Heritage Data Management System (HDMS) and Project Evaluation Program work together to provide current, reliable, objective information on Arizona's plant and wildlife species to aid in the environmental decision-making process. The information can be used to guide preliminary decisions and assessments for the Resolution Copper Project. Similarly, the FWS provides guidance for protecting wildlife.
Source of measure: Public comment submittal during scoping period
Resource affected/impacts being mitigated: These statements seek to mitigate potential adverse effects to wildlife.
Applicable alternatives: All
Authority to require: While the measure specifies guidance from other agencies, the habitats impacted are Forest Service surface resources for Alternatives 2, 3, and 4, and authority exists under 36 CFR 228.8 for these areas. In addition, the Forest Service is responsible for implementing any conservation measures brought forward during Section 7 Endangered Species Act (ESA) consultation, or any conditions specified in a Biological Opinion by FWS. For Alternative 5, 43 CFR 3809.2 provides similar authority to BLM to regulate mining to prevent unnecessary or undue degradation. For Alternative 6, the Forest Service would not have jurisdiction over the tailings storage facility, but would have authority over the pipeline corridors.
Additional ground disturbance: No additional ground disturbance anticipated.

GP-131: Implement a wildlife management plan for stormwater ponds, including wildlife exclusion fencing
Description/overview: Implement a wildlife management plan for stormwater ponds, including wildlife exclusion fencing.
Source of measure: Public comment submittal during scoping period
Resource affected/impacts being mitigated: These statements seek to mitigate potential adverse effects to wildlife.
Applicable alternatives: Alternatives 2, 3, 4, and 5
Authority to require: The habitats impacted are Forest Service surface resources for Alternatives 2, 3, and 4, and authority exists under 36 CFR 228.8 for these areas. In addition, the Forest Service is responsible for implementing any conservation measures brought forward during Section 7 ESA consultation, or any conditions specified in a Biological Opinion by FWS. For Alternative 5, 43 CFR 3809.2 provides similar authority to BLM to regulate mining to prevent unnecessary or undue degradation.
Additional ground disturbance: No additional ground disturbance anticipated.

CA-191: Reptile and Sonoran Desert Tortoise (ESA-CCA) Plan
Description/overview: Implement conservation actions detailed in the Candidate Conservation Agreement (CCA). The Candidate Conservation Agreement would be a formal agreement between the FWS and Resolution Copper to address the conservation needs of proposed or candidate species, or species likely to become candidates, before they become listed as endangered or threatened. Resolution Copper would voluntarily commit to conservation actions that would help stabilize or restore the species with the goal that listing would become unnecessary.
Source of measure: Arizona Game and Fish Department
Resource affected/impacts being mitigated: This statement seeks to mitigate potential adverse effects to wildlife.
Applicable alternatives: All
Authority to require: If solely a voluntary agreement entered into by Resolution Copper, implementation is not assured; however, once this measure is included in the ROD/Final mining plan of operations it would be required by the Forest Service. The habitats impacted are Forest Service surface resources for Alternatives 2, 3, and 4, and authority exists under 36 CFR 228.8 for these areas. In addition, the Forest Service is responsible for implementing any conservation measures brought forward during Section 7 ESA consultation, or any conditions specified in a Biological Opinion by FWS. For Alternative 5, 43 CFR 3809.2 provides similar authority to BLM to regulate mining to prevent unnecessary or undue degradation. For Alternative 6, the Forest Service would not have jurisdiction over the tailings storage facility, but would have authority over the pipeline corridors.

Additional ground disturbance: No additional ground disturbance anticipated.

CA-172: Mitigation of loss of abandoned mine or cave habitat for bats
Description/overview: Mitigate impacts on bat habitat by conducting pre-closure surveys over multiple years and multiple visits per year, to document species presence/absence and develop appropriate closure methods in coordination with AGFD, Bat Conservation International, and Forest Service biologists; implement wildlife exclusion measures pre-closure to minimize wildlife entrapment and mortality during closure; consider seasonal timing of closure on any sites with suitable maternity roosts; and identify mines, adits, and/or shafts with known bat roosting areas. If activities are adjacent to bat roosting/maternity sites, develop best management practices to reduce human encroachment.
Source of measure: Arizona Game and Fish Department
Resource affected/impacts being mitigated: These actions seek to mitigate potential adverse effects to wildlife habitat.
Applicable alternatives: Alternatives 2, 3, 4, and 5
Authority to require: If solely a voluntary agreement entered into by Resolution Copper, implementation is not assured; however, once this measure is included in the ROD/Final Mining Plan of Operations it would be required by the Forest Service. The habitats impacted are Forest Service surface resources for Alternatives 2, 3, and 4, and authority exists under 36 CFR 228.8 for these areas. In addition, the Forest Service is responsible for implementing any conservation measures brought forward during Section 7 ESA consultation, or any conditions specified in a Biological Opinion by FWS. For Alternative 5, 43 CFR 3809.2 provides similar authority to BLM to regulate mining to prevent unnecessary or undue degradation.
Additional ground disturbance: No additional ground disturbance anticipated.

CA-175: Maintain or replace access to stock tanks and Arizona Game and Fish Department wildlife waters
Description/overview: Resolution Copper would maintain or replace access to stock tanks and AGFD wildlife waters impacted by the project. Stock tanks are used to provide drinking water for livestock. AGFD constructs wildlife water developments to support a variety of wildlife, including game species. Benefits of AGFD wildlife water developments include a long lifespan; year-round, acceptable water quality for wildlife use; require no supplemental water hauling, except in rare or exceptional circumstances; minimal visual impacts and blends in with the surrounding landscape; accessible to and used by target species and excludes undesirable/feral species to the greatest extent possible; and minimized risk of animal entrapment and mortality.
Source of measure: Arizona Game and Fish Department

Resource affected/impacts being mitigated: These actions seek to mitigate potential adverse effects to livestock grazing, recreation, and wildlife habitat.
Applicable alternatives: All
Authority to require: If solely a voluntary agreement entered into by Resolution Copper, implementation is not assured; however, once this measure is included in the ROD/Final mining plan of operations it would be required by the Forest Service. The habitats impacted are Forest Service surface resources for Alternatives 2, 3, and 4, and authority exists under 36 CFR 228.8 for these areas. In addition, the Forest Service is responsible for implementing any conservation measures brought forward during Section 7 ESA consultation, or any conditions specified in a Biological Opinion by FWS. For Alternative 5, 43 CFR 3809.2 provides similar authority to BLM to regulate mining to prevent unnecessary or undue degradation. For Alternative 6, the Forest Service would not have jurisdiction over the tailings storage facility, but would have authority over the pipeline corridors.
Additional ground disturbance: No additional ground disturbance anticipated.

CA-176: Use of best management practices during pipeline construction and operations
Description/overview: Resolution Copper would adhere to best management practices during pipeline construction and operation. During pipeline construction, Resolution Copper would cover open trenching; inspect trenches routinely for entrapped wildlife and remove; provide wildlife escape ramps; inspect under construction equipment prior to use and remove any wildlife seeking cover. Resolution Copper would also include wildlife crossing structures along the pipeline corridor (overpass or underpass) and coordinate with AGFD and Forest Service biologists to determine the location, frequency, and design of wildlife crossing structures.
Source of measure: Arizona Game and Fish Department
Resource affected/impacts being mitigated: These actions seek to mitigate potential adverse effects to wildlife.
Applicable alternatives: All
Authority to require: If solely a voluntary agreement entered into by Resolution Copper, implementation is not assured; however, once this measure is included in the ROD/Final Mining Plan of Operations it would be required by the Forest Service. The habitats impacted are Forest Service surface resources for Alternatives 2, 3, and 4, and authority exists under 36 CFR 228.8 for these areas. In addition, the Forest Service is responsible for implementing any conservation measures brought forward during Section 7 ESA consultation, or any conditions specified in a Biological Opinion by FWS. For Alternative 5, 43 CFR 3809.2 provides similar authority to BLM to regulate mining to prevent unnecessary or undue degradation. For Alternative 6, the Forest Service would not have jurisdiction over the tailings storage facility, but would have authority over the pipeline corridors.
Additional ground disturbance: No additional ground disturbance anticipated.

Recreation (5 measures)

RC-212: Relocation of Arizona National Scenic Trail
Description/overview: Resolution Copper has proposed to fund the relocation of a segment of the Arizona National Scenic Trail as well as the construction of new trailheads. Approximately 9 miles of new trail would need to be built between U.S. Route 60 and NFS Road 650 near Whitford Canyon. This measure was proposed by Resolution Copper and seeks to mitigate impacts on recreational opportunities on the trail. This measure is only applicable to Alternatives 2, 3, and 4. Relocating the trail and constructing new trailheads would require additional ground disturbance but the exact area of new disturbance has yet to be determined, although it is assumed the new trail would be about 2 to 3 feet in width and approximately 3 acres of total surface area.
Source of measure: Resolution Copper
Resource affected/impacts being mitigated: These actions seek to mitigate potential adverse effects to recreation.

Applicable alternatives: Alternative 2, 3, and 4
Authority to require: As an applicant-proposed measure, implementation is not assured; however, once this measure is included in the ROD/Final mining plan of operations it would be required by the Forest Service.
Additional ground disturbance: Yes, to be determined, but roughly can be assumed that a new trail would be about 2 to 3 feet in width, and would account for approximately 3 acres of additional ground disturbance.

RC-213: Mitigate loss of bouldering at Oak Flat by establishing access to “Inconceivables"
Description/overview: To mitigate impacts on recreation through the loss of bouldering areas at Oak Flat, Resolution Copper has proposed to establish access to an alternative area known as “Inconceivables.” This area extends along cliffs for approximately 3 miles on Tonto National Forest land and is located off State Route 177. This mitigation measure is applicable to all alternatives.
Source of measure: Resolution Copper
Resource affected/impacts being mitigated: These actions seek to mitigate potential adverse effects to recreation.
Applicable alternatives: All
Authority to require: As an applicant-proposed measure, implementation is not assured; however, once this measure is included in the ROD/Final mining plan of operations it would be required by the Forest Service.
Additional ground disturbance: Yes, to be determined after further development of the proposed idea.

RC-214: Implement RUG and Superior Trail Network Plan
Description/overview: Resolution Copper has proposed to implement the Recreation User Group (RUG) and the Superior Trail Network Plan to offset loss of public roads at Oak Flat. The RUG was formed to develop a recreational trail design in the town of Superior area. The RUG has developed a conceptual plan for a trail system on the Tonto National Forest that would meet the needs and interests of different stakeholders. Within the vicinity of Superior there is a network of unpaved roads and trails, many of which are not authorized by the Tonto National Forest, that are contributing to ongoing resource degradation. The development of a trail system would help with reducing continued development of unauthorized trails. The purposes of the RUG and Superior Trail Network Plan are to provide recreation opportunities for hikers, equestrians, mountain bicyclists, and off-highway vehicle enthusiasts; provide readily accessible recreation opportunities to the Superior and Phoenix metropolitan area; offer long-term, sustainable economic benefits to the local community through recreation and ecotourism; protect soil resources in the area from erosion; and provide access to uniquely beautiful viewsheds within Tonto National Forest that are not currently accessible by authorized trails.

Attachment 1 of this Appendix has the Proposed RUG Recreation Project Conceptual Plan submitted to the Forest Service in 2019.
Source of measure: Resolution Copper
Resource affected/impacts being mitigated: These actions seek to mitigate potential adverse effects to recreation.
Applicable alternatives: All
Authority to require: As an applicant-proposed measure, implementation is not assured; however, once this measure is included in the ROD/Final Mining Plan of Operations it would be required by the Forest Service.
Additional ground disturbance: Yes, the full plan would encompass 66.5 acres; however, it is unknown whether the full plan would be approved in its entirety.

RC-215: Provide replacement campground
Description/overview: Resolution Copper has proposed to establish an alternative campground site, known as Castleberry, to mitigate the loss of Oak Flat Campground. The development of the new campground as well as access to the property would require additional ground disturbance of 41 acres.
Source of measure: Resolution Copper
Resource affected/impacts being mitigated: These actions seek to mitigate potential adverse effects to recreation.
Applicable alternatives: All
Authority to require: As an applicant-proposed measure, implementation is not assured; however, once this measure is included in the ROD/Final Mining Plan of Operations it would be required by the Forest Service.
Additional ground disturbance: Yes, additional disturbance on the Castleberry property and access to property could include up to 41 acres.

RC-216: Develop access to Oak Flat Campground while safe per MSHA regulations
Description/overview: To mitigate the future permanent loss of Oak Flat Campground, Resolution Copper has proposed to develop an access plan for the campground as long as it is safe per MSHA regulations. This would allow access to Oak Flat Campground after the land exchange has occurred and the parcel is privately owned by Resolution Copper. The exact duration and extent of access would be determined later per safety requirements by MSHA. This measure would mitigate both losses to recreation as well as impacts on tribal values, would be applicable to all alternatives, and would require no additional ground disturbance.
Source of measure: Resolution Copper
Resource affected/impacts being mitigated: These actions seek to mitigate potential adverse effects to recreation and tribal values.
Applicable alternatives: All
Authority to require: As an applicant-proposed measure, implementation is not assured; however, once this measure is included in the ROD/Final Mining Plan of Operations it would be required by the Forest Service.
Additional ground disturbance: No additional ground disturbance anticipated.

Public Health & Safety (5 measures)

FS-01: Satellite Monitoring of Tailings Storage Facility
Description/overview: High-resolution satellite imagery would be collected and processed at regular intervals. Processed output provided to the Forest Service or BLM would include beach width, tailings surface slope contours, and constructed site topography. This output could be provided for land manager verification of adherence to design criteria, as well as long-term monitoring of facility performance over time.
Source of measure: Tonto National Forest Interdisciplinary Team
Resource affected/impacts being mitigated: This statement seeks to mitigate impacts on tailings safety, which in turn is protective of human life, property, and numerous downstream resources.
Applicable alternatives: Alternatives 2, 3, 4, and 5
Authority to require: Alternatives 2, 3, and 4: 36 CFR 228.8 (Forest Service authority to regulate mining to minimize adverse environmental impacts on NFS surface resources) Alternative 5: 43 CFR 3809.2 (BLM authority to regulate mining to prevent unnecessary or undue degradation) Alternative 6: As facility would ultimately be located on private land, Forest Service would not have authority to require long-term monitoring of the tailings storage facility.

If this were to be an applicant-proposed measure for this alternative, implementation is not assured; however, once this measure is included in the ROD/Final mining plan of operations it would be required by the Forest Service.
Additional ground disturbance: No additional ground disturbance anticipated.

GP-26: Improve Resiliency of Tailings Storage Facility
Description/overview: Some recommended mitigation measures regarding the tailings storage facility to include where appropriate include the use of a liner, constructing a secondary backup containment facility, developing a mitigation plan for tailings storage facility embankment breach, implementing a cease operation plan in the event of a tailings embankment failure, requiring an environmental damage assessment in the event of a tailings embankment release, and identifying alternative energy sources for the tailings storage facility in the event of an electrical outage.
Source of measure: Public comment submittal during scoping period
Resource affected/impacts being mitigated: This statement seeks to mitigate impacts on tailings safety, which in turn is protective of human life, property, and numerous downstream resources.
Applicable alternatives: All
Authority to require: The suggestions noted in this measure are general in nature, and many of the concepts are already incorporated into the facility designs. In addition, further facility design requirements that may overlap this measure would be developed under other measures (see for example FS-227 and FS-228). To the extent additional components are developed and incorporated by the applicant into the design, they would be included in the ROD/Final mining plan of operations and would be required by the Forest Service.
Additional ground disturbance: No additional ground disturbance anticipated.

FS-227: Conduct Refined FMEA before Final EIS for the Preferred Alternative
Description/overview: The failure modes and effects analysis (FMEA) conducted by Resolution Copper is based on the DEIS alternative design documents. With more refined designs and site-specific information, a more robust and refined FMEA can be conducted. The Forest Service is requiring that this refined FMEA be conducted between the DEIS and FEIS. This exercise will inform the requirements to be specified in the ROD and ultimately incorporated into a final plan of operations. The refined FMEA would be a collaborative group process that would be led by the Forest Service. It is likely to include Forest Service personnel, cooperating agency representatives, Resolution Copper and their tailings experts and contractors, and the NEPA team and their tailings experts. This group would identify possible failure modes, their likelihood of occurring, the level of confidence in the predictions, the severity of the consequences if that failure mode were to occur, and possible controls to reduce the risk of failure. The collaborative group would likely also be asked to identify a reasonable failure scenario to use in a refined breach analysis. During an FMEA, the tailings storage facility is considered as a complete system with a number of components, including geology, foundation, engineered structures, seepage controls, drains, containment, diversions, and spillways. Sufficient information on the design and specifications of each component is needed in order to understand how they would function as a system, and how they might respond to the anticipated stresses on the system. The information needed to support a collaborative, refined FMEA would include the results of site investigations (geology and foundation), lab testing, engineering analyses, borrow material analyses and specifications, and engineered drawings and specifications. The less information available during the FMEA process, the more assumptions have to be made, leading to a less meaningful assessment that may not be representative of the true risks for the ultimate designed facility.
Source of measure: Tonto National Forest Interdisciplinary Team and Cooperating Agencies
Resource affected/impacts being mitigated: This statement seeks to mitigate impacts on tailings safety, which in turn is protective of human life, property, and numerous downstream resources.
Applicable alternatives: Preferred Alternative
Authority to require: While the footprint of the Preferred Alternative may not involve Forest Service surface resources, other aspects of the project still involve Forest Service surface resources, and the information collected under this measure is considered necessary to support both the FEIS and the final mining plan of operations.
Additional ground disturbance: No additional ground disturbance anticipated.

FS-228: Adherence to National Dam Safety Program Standards
Description/overview: For a tailings storage facility built on Federal land, the Forest Service is requiring that Resolution Copper adhere, at a minimum, to the requirements of the National Dam Safety Program discussed in "Relevant Laws, Regulations, Policies, and Plans" in section 3.10.1.3.
Source of measure: Tonto National Forest Interdisciplinary Team
Resource affected/impacts being mitigated: This statement seeks to mitigate impacts on tailings safety, which in turn is protective of human life, property, and numerous downstream resources.
Applicable alternatives: Alternatives 2, 3, 4, and 5
Authority to require: Alternatives 2, 3, and 4: 36 CFR 228.8 (Forest Service authority to regulate mining to minimize adverse environmental impacts on NFS surface resources) Alternative 5: 43 CFR 3809.2 (BLM authority to regulate mining to prevent unnecessary or undue degradation) Alternative 6: As facility would ultimately be located on private land, Forest Service would not have authority to require these specific design standards. If this were to be an applicant-proposed measure for this alternative, implementation is not assured; however, once this measure is included in the ROD/Final mining plan of operations it would be required by the Forest Service.
Additional ground disturbance: No additional ground disturbance anticipated.

FS-229: Development of an Emergency Action Plan for the Tailings Storage Facility for the Preferred Alternative
Description/overview: For a tailings storage facility built on Federal land, the Forest Service is requiring that Resolution Copper undertake Emergency Action Planning, as required under the National Dam Safety Program (Federal Emergency Management Agency 2004). The FMEA would provide key information to this process. Emergency Action Planning would include evaluation of emergency potential, inundation mapping and classification of downstream inundated areas, response times, notification plans, evacuation plans, and plans for actions upon discovery of a potentially unsafe condition. The breach analysis prepared for the DEIS is not sufficient to meet National Dam Safety Standards for emergency planning. The Forest Service will require a refined breach analysis be conducted between the DEIS and FEIS, using appropriate models, based on the outcome of the FMEA and a selected failure scenario.
Source of measure: Tonto National Forest Interdisciplinary Team
Resource affected/impacts being mitigated: This statement seeks to mitigate impacts on tailings safety, which in turn is protective of human life, property, and numerous downstream resources.
Applicable alternatives: Preferred Alternative

Authority to require: While the footprint of the Preferred Alternative may not involve Forest Service surface resources, other aspects of the project still involve Forest Service surface resources, and the information collected under this measure is considered necessary to support both the FEIS and the final mining plan of operations.
Additional ground disturbance: No additional ground disturbance anticipated.

Scenic (1 measure)

FS-03: Transmission Lines
Description/overview: Use best management practices or other guidelines (on NFS lands) that would minimize visual impacts from transmissions lines that could include: • Non-specular transmission lines, transformers, and towers; • Avoid use of monopole transmission structures; • Avoid “skylining” of transmission/communication towers and other structures. Consider topography when siting transmission structures to avoid “skylining” of structures on high ridges in the landscape; • In areas of the highest visual sensitivity with difficult access, air transport capability should be used to mobilize equipment and materials for clearing, grading, and erecting transmission towers.
Source of measure: Internal NEPA Team Scoping
Resource affected/impacts being mitigated: These measures seek to reduce and minimize the scenery impacts and project contrast of mining operations in the surrounding landscape and impacts upon sensitive viewers. All recommendations would be effective in reducing the form, line, and color contrasts presented by the project elements.
Applicable alternatives: All
Authority to require: Power line corridors occur mainly on Forest-managed lands and mitigation can be required regardless of alternative under 36 CFR 228.8 (Forest Service authority to regulate mining to minimize adverse environmental impacts on NFS surface resources)
Additional ground disturbance: No additional ground disturbance anticipated.

Cultural/Historical Resources and Tribal Values (2 measures)

RC-209: Cultural and Archaeological Data Recovery – Oak Flat HPTP
Description/overview: The "Resolution Copper Oak Flat Land Exchange Treatment Plan" (Oak Flat Historic Properties Treatment Plan [HPTP]) (Deaver and O'Mack 2019) sets out a plan for treatments to resolve the adverse effects to 42 historic properties that have been identified within the Oak Flat Federal Parcel. In accordance with the plan, Resolution Copper would conduct archaeological data recovery on sites eligible under Criterion D that would be adversely affected. Project materials and archaeological collections would be curated in accordance with 36 CFR 79 (Curation of Federally-Owned and Administered Archaeological Collections) with Gila River Indian Community, Salt River Pima-Maricopa Indian Community, and the Arizona State Museum. This measure is applicable to all alternatives and would be noted in the ROD/Final Mining Plan of Operations.
Source of measure: Resolution Copper
Resource affected/impacts being mitigated: This statement seeks to reduce impacts on cultural resources.
Applicable alternatives: All
Authority to require: Ultimately, the land exchange removes the Oak Flat parcel from Federal ownership and oversight. However, the data recovery plans are being developed as part of the Programmatic Agreement and, when signed, would be required to occur.
Additional ground disturbance: Yes, but data recovery activities would take place within the area already assumed to be disturbed in the EIS.

RC-210: Cultural and Archaeological Data Recovery – GPO HPTP
Description/overview: The GPO Research Design and data recovery plans detail treatments to resolve adverse effects on historic properties within the GPO project area with the exception of those in the Oak Flat Federal Parcel. Data recovery would be conducted on archaeological sites eligible under Criterion D within the GPO project area. Project materials and archaeological collections would be curated in accordance with 36 CFR 79 (Curation of Federally-Owned and Administered Archaeological Collections) with Gila River Indian Community, Salt River Pima-Maricopa Indian Community, and the Arizona State Museum. This measure is applicable to all alternatives and would be noted in the ROD/Final Mining Plan of Operations.
Source of measure: Resolution Copper
Resource affected/impacts being mitigated: This statement seeks to reduce impacts on cultural resources.
Applicable alternatives: All

Authority to require: Authority varies by alternative; however, the data recovery plans are being developed as part of the Programmatic Agreement and, when signed, would be required to occur.
Additional ground disturbance: Yes, but data recovery activities would take place within the area already assumed to be disturbed in the EIS.

Socioeconomics/Environmental Justice (none)

Grazing (none)

Reclamation/Other Plans (1 measure)

CA-166: BLM offered lands preservation/improvement
Description/overview: Proposed mitigation for offered lands: 7B Ranch/Lower San Pedro River Parcels • Assure that water monitoring area is preserved, and species protection features remain in place. • Remove all graffiti, commercial use, billboards, remove refuse. • Prevent unauthorized uses. • Prevent and mitigate new hazardous material that may occur on property. Appleton Ranch • Ensure water features are preserved and left intact.
Source of measure: BLM
Resource affected/impacts being mitigated: This statement seeks to reduce impacts on recreation, wildlife habitat, visual resources, and water quality.
Applicable alternatives: All
Authority to require: With respect to the offered lands, these proposed measures apply to actions Resolution Copper would take prior to the land exchange, would take place through the ongoing appraisal and exchange process, and would no longer be applicable after the exchange occurs.
Additional ground disturbance: Yes, but within the land exchange parcels as disclosed in the DEIS.

Other Mitigation and Monitoring Measures Not Considered in Chapter 3 Impacts Analysis

While not analyzed for effectiveness in the EIS, other mitigation and monitoring measures were suggested during the scoping process, during alternatives development, or would be likely under a permit or authorization required for the mine. As stated above, the Forest Service has the authority to limit

impacts on Forest Service surface resources, but not those imposed by another regulating authority or on private land outside of regulating authorities.

The Forest Service would not have authority to require the items listed below, but they could be implemented in the future to limit impacts. These measures were not considered within the analysis of the EIS.

The Forest Service welcomes comments on these ideas for future consideration of incorporation by other agencies with permitting authority or Resolution Copper as an Applicant-Committed Environmental Protection Measure.

Mitigation and Monitoring Required by Other Regulatory and Permitting Agencies

Mitigation and monitoring items under this heading are within the authority of other regulatory permitting agencies, including the Arizona Department of Environmental Quality and Arizona Department of Water Resources. At this point in the NEPA process, the Forest Service has no authority, obligation, or expertise to determine or enforce compliance for the measures included in this category, as they have neither been required by other agencies or agreed to by Resolution Copper. However, as with other measures discussed, if these measures are eventually included in the ROD/Final Mining Plan of Operations, they would be required by the Forest Service. They are presented here to facilitate disclosure of currently known mitigation and monitoring and their consideration in impacts analyses. The mitigation and monitoring measures in this category include permit requirements and stipulations from legally binding permits and authorizations such as the air quality permit, Aquifer Protection Permit, and groundwater withdrawal permit.

Many of these permits are not yet issued but would be issued prior to approval of the final mining plan of operations. Those permits received prior to the issuance of the final ROD may need to be modified to reflect the alternative selected by the deciding official. These regulatory and permitting agencies would share monitoring results and any instances of noncompliance with the Forest Service. The Forest Service would use the information provided by the regulatory and permitting agencies to determine compliance with the decision that would be documented in the final ROD and compliance with the final mining plan of operations. Some of the other permits, licenses, and authorizations (see table 1.5.4-1 in chapter 1) that would be required for the mine to be operational (and may include additional mitigations in addition to those noted here) include:

- Aquifer Protection Permit (APP)
- Arizona Pollutant Discharge Elimination System (AZPDES) Permit
- Clean Water Act Section 401 Certification
- Special Use Permits
- Project-Specific Section 404 Clean Water Act Permit
- Air Quality Control Permit

Geology, Minerals, Subsidence (none)

Soils and Vegetation (none)

Noise and Vibration (3 measures)

GP-132: Maintain equipment regularly to reduce noise from heavy machinery operations
Description/overview: Maintain equipment regularly to reduce noise from heavy machinery operations
Source of measure: Public comment submittal during scoping period
Resource affected/impacts being mitigated: This statement seeks to reduce impacts from noise.
Applicable alternatives: All
Possible authority to require: Pinal County
Additional ground disturbance: No additional ground disturbance anticipated.

GP-133: Establish procedures for reporting noise complaints
Description/overview: Establish procedures for reporting noise complaints, such as providing a telephone number for the public to report noise complaints and posting the number at various locations
Source of measure: Public comment submittal during scoping period
Resource affected/impacts being mitigated: This statement seeks to reduce impacts from noise.
Applicable alternatives: All
Possible authority to require: Pinal County
Additional ground disturbance: No additional ground disturbance anticipated.

GP-134: Develop noise limits and a fine structure for noise violations
Description/overview: Develop noise limits and a fine structure for noise violations
Source of measure: Public comment submittal during scoping period
Resource affected/impacts being mitigated: This statement seeks to reduce impacts from noise.
Applicable alternatives: All
Possible authority to require: Pinal County
Additional ground disturbance: No additional ground disturbance anticipated.

Transportation and Access (none)

Air Quality (3 measures)

GP-111: Identify monitoring thresholds for fugitive dust pollution
Description/overview: Identify monitoring thresholds for fugitive dust pollution
Source of measure: Public comment submittal during scoping period
Resource affected/impacts being mitigated: This statement seeks to reduce impacts on air quality.
Applicable alternatives: All
Possible authority to require: Pinal County Air Quality Control District
Additional ground disturbance: No additional ground disturbance anticipated.

GP-112: Implement enforcement strategies for air quality mitigation
Description/overview: Implement enforcement strategies for air quality mitigation.
Source of measure: Public comment submittal during scoping period
Resource affected/impacts being mitigated: This statement seeks to reduce impacts on air quality.

Applicable alternatives: All
Possible authority to require: Pinal County Air Quality Control District
Additional ground disturbance: No additional ground disturbance anticipated.

GP-110: Reevaluate GPO dust abatement strategy
Description/overview: Reevaluate the GPO dust abatement strategy and implement additional mitigation measures as needed
Source of measure: Public comment submittal during scoping period
Resource affected/impacts being mitigated: This statement seeks to reduce impacts on air quality.
Applicable alternatives: All
Possible authority to require: Pinal County Air Quality Control District
Additional ground disturbance: No additional ground disturbance anticipated

Water Resources (9 measures)

RC-217: Compensatory mitigation plan (404 permit)
Description/overview: Appendix to EIS for impacts on ephemeral drainages and waters of the U.S.
Source of measure: Resolution Copper
Resource affected/impacts being mitigated: This statement seeks to reduce impacts on water resources.
Applicable alternatives: Alternative 5 and 6 that would require a 404 permit
Possible authority to require: As noted in chapter 1 of the EIS, the U.S. Army Corps of Engineers would have a permitting role if either Alternative 5 or 6 is pursued and would rely on this EIS to support their decision. Compensatory mitigation is a required component, and preliminary concepts have been included as part of the EIS.
Additional ground disturbance: Yes, negligible and not quantifiable, more details found within Draft Resolution Copper Project Clean Water Act Section 404 Conceptual Compensatory Mitigation Plan (see appendix D to EIS)

GP-76: Test stormwater runoff through running washes
Description/overview: Test stormwater runoff for toxins to prevent recreational exposure through running washes
Source of measure: Public comment submittal during scoping period
Resource affected/impacts being mitigated: This statement seeks to reduce impacts on water resources and public health and safety.
Applicable alternatives: All
Possible authority to require: Arizona Department of Environmental Quality under the AZPDES permit
Additional ground disturbance: No additional ground disturbance anticipated.

GP-79: Disclose results of water monitoring
Description/overview: Monitor groundwater and surface water quality and publicly disclose the results quarterly.
Source of measure: Public comment submittal during scoping period
Resource affected/impacts being mitigated: This statement seeks to reduce impacts on water resources.
Applicable alternatives: All
Possible authority to require: Arizona Department of Environmental Quality under the APP or AZPDES permits
Additional ground disturbance: No additional ground disturbance anticipated.

GP-91: Clarify “interim shutdown”
Description/overview: Clarify “interim shutdown” mitigation measures relative to water discharge.
Source of measure: Public comment submittal during scoping period
Resource affected/impacts being mitigated: This statement seeks to reduce impacts on water resources.
Applicable alternatives: All
Possible authority to require: Arizona Department of Environmental Quality under the APP or AZPDES permits

Additional ground disturbance: No additional ground disturbance anticipated.

GP-92: Detail methodology for monitoring and mitigation of discharge water
Description/overview: Describe the methods and regulatory oversight that will be applied to monitor and mitigate the quality of mine and tailings discharge water.
Source of measure: Public comment submittal during scoping period
Resource affected/impacts being mitigated: This statement seeks to reduce impacts on water resources.
Applicable alternatives: All
Possible authority to require: Arizona Department of Environmental Quality under the APP or AZPDES permits
Additional ground disturbance: No additional ground disturbance anticipated.

FS-151: Implement a long-term monitoring and mitigation plan for releases
Description/overview: A long-term monitoring and mitigation plan for such releases (i.e., long-term seepage to groundwater and surface waters) is an essential element of a Forest Service–approved mining plan of operations.
Source of measure: Internal scoping
Resource affected/impacts being mitigated: This statement seeks to reduce impacts on water resources.
Applicable alternatives: All
Possible authority to require: The first part of this appendix focuses on the Forest Service mitigation and monitoring. Additional monitoring plans could be associated with other agencies and coordinated with the Forest Service, including plans required by the Arizona Department of Environmental Quality under the APP or AZPDES permits.
Additional ground disturbance: No additional ground disturbance anticipated.

CA-206: Wells up- and down-gradient of site
Description/overview: Installing wells up- and down-gradient of the site would allow analysis of the groundwater elevation contours, discontinuities within the bedrock with seepage potential, and would establish baseline groundwater quality data to support further analysis of impacts and mitigation
Source of measure: Arizona Department of Environmental Quality
Resource affected/impacts being mitigated: This statement seeks to reduce impacts on water resources.
Applicable alternatives: All
Possible authority to require: Monitoring wells are an integral part of the Arizona Department of Environmental Quality APP permitting process. Additional wells that extend beyond the area required under the APP may also be considered as part of monitoring efforts.
Additional ground disturbance: No additional ground disturbance anticipated.

GP-37: Install Additional Deep Monitoring Wells
Description/overview: Additional deep monitoring wells should be installed with "clearly defined water quality goals" for groundwater geochemistry.
Source of measure: Public comment submittal during scoping period
Resource affected/impacts being mitigated: This statement seeks to reduce impacts on water resources.
Applicable alternatives: All
Possible authority to require: Monitoring wells are an integral part of the Arizona Department of Environmental Quality APP permitting process. Additional wells that extend beyond the area required under the APP may also be considered as part of monitoring efforts.
Additional ground disturbance: Yes, with some impacts of drilling additional wells quantified in the seeps and spring monitoring and mitigation plan (see RC-211)

CA-168: Streams and Riparian Ecosystem mitigation of impacts
Description/overview: Contribution to ongoing restoration efforts in the Middle Gila HUC 8 watershed could be appropriate for inclusions in mitigation plans. Where unavoidable impacts on aquatic resources cannot be restored or replaced where the effects occur, suggest compensation within the same and then adjacent watersheds be prioritized over more distant options. Such projects could include 1) restoration work via vegetation removal within the Gila River Indian Community along the Lower Salt and Agua Fria Rivers; 2) BLM restoration work via mesquite removal and establishment of native grasses within the San Pedro Riparian National Conservation area near the Upper San Pedro HUC.
Source of measure: Environmental Protection Agency
Resource affected/impacts being mitigated: This statement seeks to reduce impacts on water resources and riparian ecosystems.
Applicable alternatives: All
Possible authority to require: As noted in chapter 1 of the EIS, the U.S. Army Corps of Engineers would have a permitting role if either Alternative 5 or 6 is pursued and would rely on this EIS to support their decision. Compensatory mitigation is a required component, and preliminary concepts have been included as part of the EIS. The types of measures discussed are similar in nature to those included in the conceptual compensatory mitigation, and may form part of further changes to that mitigation package. There would be no permitting role for the U.S. Army Corps of Engineers for Alternatives 2, 3, or 4, and these measures would only be implemented if brought forth voluntarily by Resolution Copper.
Additional ground disturbance: Yes, ground disturbance would be preliminarily estimated in the Draft Resolution Copper Project Clean Water Act Section 404 Conceptual Compensatory Mitigation Plan (see appendix D to EIS)

Wildlife (6 measures)

CA-185: Reduce impacts on Golden Eagles
Description/overview: **Golden eagle –** Near West and Peg Leg tailings storage facility sites are within 10 miles of two active nest sites and one potential nest site; impacts include loss of foraging habitat at tailings storage facility and mine facilities. • Identify raptor resources potentially affected; recommend minimum 3-year monitoring period prior to construction to identify nesting, foraging, and wintering habitats and, if feasible, include one cycle of prey population fluctuations (FWS guidelines 2002) • Monitor nest productivity at active nest sites within 5 miles of project boundaries pre- and post-construction to see if land conversion and habitat loss impact nest productivity; document changes. Carry into reclamation phase and evaluate post-closure reclamation and raptor response. • Utilize seasonal and/or spatial buffer zones for level and duration of construction activities during nesting period at occupied versus unoccupied nest sites (see Utah Field Office Guidelines for Raptor Protection from Human and Land Use Disturbances (USFWS 2002); and time construction outside breeding season if feasible.

• Prevent additional encroachment of human activity on nest sites (i.e., new roads, trails etc.); acquire lands around nest sites; create habitat management plans around nest sites
Source of measure: Arizona Game and Fish Department
Resource affected/impacts being mitigated: This statement seeks to reduce impacts on wildlife.
Applicable alternatives: All
Possible authority to require: This type of mitigation could be required as an outcome of Section 7 ESA consultation with FWS. If so, the Forest Service is responsible for implementing any conservation measures brought forward during Section 7 ESA consultation, or any conditions specified in a Biological Opinion by FWS.
Additional ground disturbance: No additional ground disturbance anticipated.

CA-186: Reduce impacts on Peregrine Falcon
Description/overview: **Peregrine Falcon –** active breeding along Apache Leap; tier mitigation to USFWS 2003 Monitoring Plan for the American Peregrine Falcon. A species recovered under the Endangered Species Act. • Monitor nest productivity along Apache Leap.
Source of measure: Arizona Game and Fish Department
Resource affected/impacts being mitigated: This statement seeks to reduce impacts on wildlife.
Applicable alternatives: All
Possible authority to require: This type of mitigation could be required as an outcome of Section 7 ESA consultation with FWS. If so, the Forest Service is responsible for implementing any conservation measures brought forward during Section 7 ESA consultation, or any conditions specified in a Biological Opinion by FWS.
Additional ground disturbance: No additional ground disturbance anticipated.

CA-187: Reduce impacts on Migratory and Breeding Birds
Description/overview: Migratory and breeding birds – tied to impacts and mitigation for riparian habitats. During the initial project construction and startup and delivery of tailings material to tailings storage facility site(s), adult migratory bird species that are currently nesting are likely to abandon nests during tailings delivery/deposit. This impact is likely to be lessened once delivery starts as birds are not likely to begin nesting while materials are being deposited.

• Initiate construction outside breeding periods for species that use saguaros (SGCN: elf owl, Gila woodpecker, gilded flicker, white-winged dove), key riparian habitats • Develop an Avian and Bat Protection Plan in coordination with the AGFD.
Source of measure: Arizona Game and Fish Department
Resource affected/impacts being mitigated: This statement seeks to reduce impacts on wildlife.
Applicable alternatives: All
Possible authority to require: This type of mitigation could be required as an outcome of Section 7 ESA consultation with FWS. If so, the Forest Service is responsible for implementing any conservation measures brought forward during Section 7 ESA consultation, or any conditions specified in a Biological Opinion by FWS. The habitats impacted are Forest Service surface resources for Alternatives 2, 3, and 4, and authority exists under 36 CFR 228.8 for these areas. For Alternative 5, 43 CFR 3809.2 provides similar authority to BLM to regulate mining to prevent unnecessary or undue degradation. For Alternative 6, the Forest Service would not have jurisdiction over the tailings storage facility, but would have authority over the pipeline corridors.
Additional ground disturbance: No additional ground disturbance anticipated.

GP-122: Implement impact avoidance and minimization measures for special status species
Description/overview: Implement impact avoidance and minimization measures for special status species
Source of measure: Public comment submittal during scoping period
Resource affected/impacts being mitigated: This statement seeks to reduce impacts on wildlife.
Applicable alternatives: All
Possible authority to require: This type of mitigation could be required as an outcome of Section 7 ESA consultation with FWS. If so, the Forest Service is responsible for implementing any conservation measures brought forward during Section 7 ESA consultation, or any conditions specified in a Biological Opinion by FWS. The habitats impacted are Forest Service surface resources for Alternatives 2, 3, and 4, and authority exists under 36 CFR 228.8 for these areas. For Alternative 5, 43 CFR 3809.2 provides similar authority to BLM to regulate mining to prevent unnecessary or undue degradation. For Alternative 6, the Forest Service would not have jurisdiction over the tailings storage facility, but would have authority over the pipeline corridors.
Additional ground disturbance: No additional ground disturbance anticipated.

CA-189: Surveys of Riparian and Aquatic Species
Description/overview: Riparian and Aquatic Species – native fish, lowland leopard frogs, Sonoran mud turtle, southwestern willow flycatcher, western yellow-billed cuckoo, common black-hawk, Arizona Bell's vireo • Conduct pre-construction species and habitat surveys and monitoring for riparian and aquatic species.
Source of measure: Arizona Game and Fish Department
Resource affected/impacts being mitigated: This statement seeks to reduce impacts on wildlife
Applicable alternatives: All
Possible authority to require: This type of mitigation could be required as an outcome of Section 7 ESA consultation with FWS. If so, the Forest Service is responsible for implementing any conservation measures brought forward during Section 7 ESA consultation, or any conditions specified in a Biological Opinion by FWS. The habitats impacted are Forest Service surface resources for Alternatives 2, 3, and 4, and authority exists under 36 CFR 228.8 for these areas. For Alternative 5, 43 CFR 3809.2 provides similar authority to BLM to regulate mining to prevent unnecessary or undue degradation. For Alternative 6, the Forest Service would not have jurisdiction over the tailings storage facility, but would have authority over the pipeline corridors.
Additional ground disturbance: No additional ground disturbance anticipated.

CA-177: Special Species Surveys prior to construction and site-specific plans
Description/overview: Conduct special status species surveys prior to construction of tailings pipeline corridors across perennial or intermittent streams and rivers (e.g., Gila River, Mineral Creek, Devil's Canyon) and designated Critical Habitats to determine species presence/absence. Develop site-specific wildlife mitigation plan in coordination with Arizona Game and Fish Department, FWS, and Forest Service biologists to address construction-related actions to avoid, minimize, and mitigate impacts on special status species (e.g., timing of construction, species relocations, etc.).
Source of measure: Arizona Game and Fish Department
Resource affected/impacts being mitigated: This statement seeks to reduce impacts on wildlife.
Applicable alternatives: All
Possible authority to require: This type of mitigation could be required as an outcome of Section 7 ESA consultation with FWS. If so, the Forest Service is responsible for implementing any conservation measures brought forward during Section 7 ESA consultation, or any conditions specified in a Biological Opinion by FWS. The habitats impacted are Forest Service surface resources for Alternatives 2, 3, and 4, and authority exists under 36 CFR 228.8 for these areas. For Alternative 5, 43 CFR 3809.2 provides similar authority to BLM to regulate mining to prevent unnecessary or undue degradation. For Alternative 6, the Forest Service would not have jurisdiction over the tailings storage facility, but would have authority over the pipeline corridors.
Additional ground disturbance: No additional ground disturbance anticipated.

Recreation (1 measure)

GP-230 Arizona Trail construction considerations
Description/overview: Incorporate construction measures into any road crossings, pipeline crossings, or reroutes of the Arizona National Scenic Trail to minimize impediments to trail use and minimize visual impacts on trail users.
Source of measure: Arizona Trail Association comment
Resource affected/impacts being mitigated: This statement seeks to reduce impacts on recreation.
Applicable alternatives: All
Possible authority to require: This would likely be an applicant-proposed measure, and if so implementation is not assured; however, once this measure is included in the ROD/Final Mining Plan of Operations it would be required by the Forest Service. Depending on the location of the crossing, there could be authority under 36 CFR 228.8 for these areas.
Additional ground disturbance: Yes, additional ground disturbance would be expected in order to bury the pipeline near the Arizona Trail.

Public Health & Safety (1 measure)

GP-113: Provide PPE to employees
Description/overview: Provide employees with personal protective equipment specific to deep shaft mining hazards.
Source of measure: Public comment submittal during scoping period
Resource affected/impacts being mitigated: This statement seeks to reduce impacts on public health and safety.
Applicable alternatives: All.
Possible authority to require: MSHA and OSHA
Additional ground disturbance: No additional ground disturbance anticipated.

Scenic (none)

Cultural/Historical Resources and Tribal Values (none)

Socioeconomic/Environmental Justice (none)

Livestock and Grazing (none)

Reclamation/Other Plans (1 measure)

GP-102: Require adequate bond amount
Description/overview: Require an adequate bond amount for mine reclamation.
Source of measure: Public comment submittal during scoping period
Resource affected/impacts being mitigated: This statement seeks to reduce impacts on long-term reclamation, soils, and vegetation post-closure.
Applicable alternatives: All
Possible authority to require: U.S. Forest Service, BLM, Arizona Department of Environmental Quality (APP program), and Arizona State Mine Inspector would all require bonding on the project for various components.
Additional ground disturbance: No additional ground disturbance anticipated.

Attachment 1 – RUG Recreation Project Conceptual Plan

Attachment 2 – Alternative 6 Proposed Mitigation Routes Map

SUPERIOR, ARIZONA
RECREATION PROJECT CONCEPTUAL PLAN
Recreation User Group

Prepared for:

Recreation User Group

Project Number: 807.135

March 2019

WestLand Resources

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(follow text)

1. INTRODUCTION

In 2016, the Recreation User Group (the Group) was formed to develop a recreational trail design within the vicinity of Superior, in Pinal County, Arizona (the Project Area; **Figure 1**). The Group was charged with developing a conceptual plan for a trail system on the Tonto National Forest (TNF) that will meet the needs and interests of different stakeholder groups while also meeting the management priorities of the U.S. Forest Service (USFS). The proposed trail network occurs on a mixture of public lands or public rights-of-way and private land within portions of Township 2 South, Range 11-13 East, and Township 3 South, Range 12 East (**Figure 2**). The majority occur on the Globe Range District of the TNF, and a small portion occurs on private land owned or managed by Resolution Copper (Resolution).

A network of unpaved roads and trails, many of which are user-created alignments that are not authorized by the USFS, currently exists within the Project Area. These trails and roads have resulted in ongoing resource degradation. The Group, which is comprised of representatives from the Town of Superior's intended recreational users, including hikers, equestrians, mountain bicyclists and off-highway vehicle (OHV) enthusiasts, was created to identify recreational resources and develop a conceptual layout for the recreational trail design (the Project). On July 25, 2018, the Group voted to move forward with the preparation of the conceptual plan for submittal to the USFS.

This report has been prepared to detail the review process used to develop the conceptual plan; the existing conditions within the Project Area; the project construction, maintenance, and funding; the members of the Group; and references cited.

2. BACKGROUND

2.1. History of the Area

The proposed trail system is located on TNF lands adjacent to Superior, Arizona, a mining town that like many mining towns has been subject to the inherently cyclical nature of the mining industry. The Superior area is a one-hour drive from Phoenix, a city with a population of more than 4.73 million in the greater metropolitan area. With its proximity to Phoenix, the TNF is "one of the most-visited 'urban' forests in the United States (approximately 5.8 million visitors annually)" (TNF 2019)[1].

Superior, which serves as a gateway to the TNF, is surrounded by natural beauty and world class recreation opportunities on the TNF that are currently unrecognized, underdeveloped, and subject to misuse, including unauthorized roads and trails, wildcat dumping, and informal target practice sites.

1 https://www.fs.usda.gov/tonto/; accessed on February 7, 2019.

2.2. Project Purpose

There is a need for a trail system in the vicinity of Superior, Arizona, in order to reduce the haphazard development of unauthorized trails that has led to the degradation of riparian habitat and impacts to wildlife and plant species. The purpose of the Project is to provide a recreational trail system within the TNF with the following characteristics:

- Provides recreation opportunities for hikers, equestrians, mountain bicyclists and OHV enthusiasts.
- Is readily accessible to Superior and the Phoenix metropolitan area
- Offers long-term, sustainable economic benefits to the local community through recreation and ecotourism
- Protects soil resources in this area from erosion, thus preventing sediment yield into surface waters
- Provides access to uniquely beautiful viewsheds within TNF that are not currently accessible by authorized trails

3. PROJECT AREA DESCRIPTION

3.1. Existing Land Uses

Land uses within TNF lands near the Project Area consist predominantly of livestock grazing, mining, and outdoor recreation including hiking, birding, horseback riding, mountain biking and off-roading. Additionally, hunting regulated by Arizona Game and Fish Department occurs on TNF lands within and adjacent to the Project Area (Game Units 24A and 37B), and an informal shooting area is located near the upper reach of Arnett Canyon. There are a number of areas devoid of vegetation that appear to be dispersed camp sites or staging areas. Several isolated illegal trash dumps are also scattered around the Project Area. Where the terrain is rocky and steep, and access is more challenging, the landscape remains relatively undisturbed. With the exception of the portion of the Arizona National Scenic Trail (AZNST) that crosses through the Project Area, existing trails on TNF lands are primarily unauthorized motorized and non-motorized trails (**Table 1**).

Table 1. Existing Unauthorized Trails on USFS Lands within the Project Area

Trail Type	Existing (miles)
Motorized	24.6
Motorized (single track)	0
Non-Motorized	17.3
TOTAL	**41.9**

Land uses on private and state lands adjacent to the Project Area include rural and suburban residential neighborhoods, livestock grazing, recreation, industrial activities such as mining and an active quarry. The Boyce Thompson Arboretum State Park, an Important Bird and Biodiversity Area recognized by Audubon Arizona, is located immediately north of the northwestern extent of the proposed trail system. The northeast portion of the proposed trail system consists of private property in Superior and includes facilities such as the Town of Superior waste water treatment plant, Superior Municipal Airport, and the Superior Unified School District. The Perlite Superior Plant is located east of Picketpost Mountain, immediately north of the north central portion of the trail system. Two private inholdings are located along Arnett Creek in the central east portion of the Project Area owned by a cattle company and a living trust.

In general, more extensive human disturbance occurs within the eastern portion of the Project Area, while the western portion remains relatively undisturbed.

3.2. Physical Features

The Project Area is located in the Central Highlands Physiographic Province, a transitional area between the Colorado Plateau Physiographic Province and the Basin and Range Physiographic Province (Ffolliott 1999). Elevations within the Project Area range from approximately 2,400 feet (ft) above mean sea level (amsl) in the lower reach of Arnett Creek to the summit of Picketpost Mountain at approximately 4,375 ft amsl. Topography within the Project Area is associated with the foothills of surrounding mountains and is dominated by steep to rolling terrain and includes highly scenic features such as standing boulders and other rock outcrops, dramatic rock faces, narrow rocky ridges, and sharply incised canyons.

The terrain within the Project Area can be generally divided into two areas. The eastern portion of the Project Area, between State Route 177 and the eastern ridge of Wood Canyon, is characterized by gently rolling hills. This lowland area affords extensive views of the Apache Leap formation to the east and Picketpost Mountain to the west. The portion of the Project Area located to the west, between Wood and Telephone Canyons, is characterized by more rugged terrain created by the ridges and drainages of the Canyons. These formations follow a roughly parallel course until the two canyons reach the lower slopes of Picketpost Mountain.

3.3. Climate and Air

The regional climate in the vicinity of the Project Area is characterized as semiarid, with long periods of little or no precipitation (Western Regional Climate Center 2019)[2]. Precipitation falls in a bimodal pattern: most of the annual rainfall within the region occurs during the winter and summer months,

[2] https://wrcc.dri.edu/Climate/west_coop_summaries.php; accessed on February 7, 2019.

with dry periods characterizing spring and fall. The average annual precipitation in the Superior region is 20.22 inches, with just over half occurring between November and April (U.S. Climate Data 2019)[3].

Air quality within the vicinity of the Project Area currently meets National Ambient Air Quality Standards (NAAQS) standards for the seven "criteria pollutants": carbon monoxide (CO), sulfur dioxide (SO_2), particulates with an aerodynamic diameter less than or equal to a nominal 10 µm (PM_{10}), particulates with an aerodynamic diameter less than or equal to a nominal 2.5 µm ($PM_{2.5}$), ozone (O_3), nitrogen dioxide (NO_2), and lead (Pb). The National Park Service has a long-term air quality dataset for the Tonto National Monument located to characterize the air quality in the Superstition Wilderness, located north of the Project Area, which indicates air quality is good and air pollution levels are lower than in populated areas. All of the areas within the Project Area are in attainment status. The nearest non-attainment areas include the Hayden airshed, which is in non-attainment for PM_{10} immediately east of the Project Area, and the Phoenix airshed, which is in non-attainment for O_3.

3.4. Vegetation

Based on the broad scale biotic community mapping of Brown and Lowe (Brown and Lowe 1980), the majority of the Project Area is mapped as the Arizona Upland Subdivision of Sonoran Desertscrub (Turner and Brown 1982), with vegetation characteristic of that biotic community present, including saguaro (*Carnegiea gigantea*), paloverde (*Parkinsonia* spp.), jojoba (*Simmondsia chinensis*) and occasional crucifixion thorn (*Canotia holacantha*).

Telegraph Canyon, Arnett Creek, Queen Creek, and some of the unnamed side canyons and springs within the Project Area support relatively narrow bands or patches of riparian vegetation consistent with Interior Riparian Deciduous Forests and Woodlands (Minckley and Brown 1994). Fremont cottonwood (*Populus fremontii*), Goodding's willow (*Salix gooddingii*), Arizona sycamore (*Platanus wrightii*), Arizona walnut (*Juglans major*), netleaf hackberry (*Celtis reticulata*), seepwillow (*Baccharis salicifolia*), California buckthorn (*Rhamnus californica*), and the nonnative saltcedar (*Tamarix* sp.) are the dominant species in these areas. The other ephemeral drainages, exhibit xeroriparian vegetation, with plant species composition similar to that of the surrounding upland areas, but in higher stature and densities.

3.5. Surface Water Features

Intermittent and near-perennial surface waters in Arnett and Queen creeks support riparian plant communities and aquatic and wetland features within portions of the Project Area. The riparian woodlands are represented by narrow, linear stands comprised of Fremont cottonwood, Goodding's willow, Arizona walnut, and Arizona sycamore and salt cedar. The linear stands are largely contiguous with occasional breaks in the canopy.

3 https://www.usclimatedata.com/climate/superior/arizona/united-states/usaz0228; accessed on February 7, 2019.

4. PROJECT DESCRIPTION

4.1. CONCEPTUAL PLAN DEVELOPMENT AND COMMUNITY INVOLVEMENT

The Project was first proposed by Resolution to TNF as a mitigation measure for Resolution's planned mining activities. The Group was developed as part of TNF's efforts to engage the local community throughout the planning and development process. Stakeholders were identified for the Group with the intention of creating a well-designed and well-implemented trail system that meets stakeholder needs. The Group ultimately included representatives from the Town of Superior, the local community, Resolution, and members of the outdoor recreation community (see **Table 3** for Group members). Additionally, TNF representatives attended regularly to provide input and direction for the Group.

The Project is located within Forest Plan Management Area 2F, and the proposed trail system must conform with the management priorities for this management area, which predominantly focuses on wildlife habitat improvement, water quality maintenance, livestock forage production, and dispersed recreation. The Forest plans to manage watersheds to improve them to a satisfactory or better condition and improve and manage adjacent riparian areas to benefit riparian dependent resources (USFS 1985, page 85).

The following is direction provided directly from the TNF Plan (USFS 1985) for the Project Area:

- Continue periodic inspection and maintenance of existing wildlife exclusions and restoration projects. Develop reports as needed to describe results of studies. Improve the level of protection and maintenance at these sites to ensure their continued informational value for wildlife management (USFS 1985, page 87).
- Based on Transportation Operation and Maintenance (O&M) Plans, identify alternative routes for new trails near urban centers and/or main travel routes. Gather information for cost estimating and design criteria. Includes trail location and selection, survey design and field review (USFS 1985, page 89).
- O&M of entire trail system to provide for a variety of user experience levels, resource protection and public safety. Includes trail condition surveys and maintenance plans (USFS 1985, page 89).

During the conceptual plan development for the Project Area, the Group balanced TNF management and recreation priorities with the priorities identified by the stakeholders. Ultimately, the following goals for the trail network design were identified:

(a) consolidate the existing trail network to reduce unauthorized disturbance;
(b) allow for a diverse range of trail types for both motorized and non-motorized uses;
(c) maximize and preserve views of the outstanding natural scenery of the area;

(d) segregate use types as necessary to minimize conflicts and facilitate public safety;
(e) be sustainable and require minimal maintenance;
(f) be able to be constructed in phases.

The Group has met on a regular basis since 2016 (**Table 2**). Conceptual trail routes were developed using aerial imagery, topographic information and the local expertise of Group members. The Group engaged an environmental consultant (WestLand Resources, Inc.) to review cultural and biological resources within the proposed trail routes as well as a trail design consultant (Southwest Trail Solutions) to assist with the development of the trail design and resource review process.

Table 2. Recreation User Group Meeting Dates *

Day	Year
September 24	2015
November 30	2015
February 10	2016
April 13	2016
September 14	2016
December 7	2016
February 8	2017
April 12	2017
October 10	2017
November 9	2017
December 13	2017
February 14	2018
April 11	2018
July 25	2018
November 14	2018
January 9	2019

* List of meeting dates is based on information provided on the Superior Arizona Community Working Group website: https://superiorazcwg.org/category/meeting-notes/recreation-user-group/. CWG Recreation & Access Task Force Meeting dates are excluded from this list.

The stakeholder representatives comprising the Group membership are listed in **Table 3**.

Table 3. Recreation User Group Members

Representative	Organization
John Bricker	Tonto Recreation Alliance
Rich Smith	Tonto Recreation Alliance
Kevin Patterson	Tonto Recreation Alliance
Mila Besich-Lira	Town of Superior
Todd Pryor	Town of Superior
Elizabeth Butler	Friends of Tonto National Forest & Equestrians
Jim Schenck	Superior Community Working Group
Greg Waterman	Sun City Anthem Hiking Club
Bruce Odegaard	Sun City Anthem Hiking Club
Lynn Martin	Ranching community
George Martin	Ranching community
Rick Schonfeld	WestLand Resources, Inc.
Mark Flint	WestLand Resources, Inc./Southwest Trail Solutions
Mary Morissette	Resolution Copper
Erik Filsinger	Queen Creek Coalition
Patrick Kell	International Mountain Bicycling Association
John Godec	Godec, Randall & Associates
Debra Duerr	Godec, Randall & Associates
Bill Volger	Legends of Superior Trails (LOST)
Nancy Volger	Legends of Superior Trails (LOST)

4.2. DESIGN

The preliminary trail designs were developed by the Group stakeholders and then refined based on field reconnaissance and cultural resources identified for avoidance. The trail alignments and trailhead areas were surveyed for impacts to cultural resources. For the trail alignments, a corridor width of 10 meters to either side of the proposed travel way (20 meters total) was surveyed to ensure the conceptual plan does not conflict with cultural resources that are eligible for the National Register of Historic Places. The preliminary designs were adjusted where needed to ensure each trail alignment is constructible, consistent with USFS construction standards, sustainable, and navigable.

During field reconnaissance, trail designers identified the opportunity to segregate the two major trail use categories – motorized and non-motorized – into different sections of the trail system. The ridge line extending approximately north/south separating Telegraph Canyon and Wood Canyon serves as a natural boundary between the two use areas (**Figure 2**). One portion of the trail system, north and

east of Wood Canyon, was designed primarily for operation of motorized equipment, both two-wheeled (motorcycles) and four-wheeled (small all-terrain vehicles and larger jeeps and sport-utility vehicles). The other portion of the trail, to the west of Wood Canyon, was designed primarily for non-motorized recreation (equestrian, mountain biking, and hiking).

Physically separating the two categories of trail use meets the Groups' goals of providing a diverse range of trail types in a safe and sustainable way. There are two exceptions to this segregation, however. A single new non-motorized trail has been proposed within the lowlands of the primarily-motorized section to provide a more moderate non-motorized trail with easy access from Superior and the highways. The other exception is the presence of an existing designated motorized USFS road within the portion western portion of the Project Area that is primarily non-motorized. A short segment of new motorized trail is proposed to connect the motorized trail system through the primarily non-motorized portion of the Project Area to the existing USFS road.

Potential locations for trailhead parking areas which were also segregated for motorized and non-motorized (primarily equestrian) uses. Users of both types of trails often use trailers, so the trailhead for each type of trail was designed to provide ample room for parking and unloading. All trailheads will be located within the lowlands in the northeast of the Project Area to provide easy access to the trailheads from Superior and the highways.

All trails are designed to maximize long-term sustainability and minimize erosion with consideration given to grade, angle, slope, and clearance. The trail system design also considers existing roads, unauthorized trails, and other sources of resource degradation and/or public safety concerns within the Project Area and identifies strategies for addressing these issues. The trail system is also designed to provide a variety of trail difficulty levels ranging from novice to expert. Design standards for the two user types (motorized vs. non-motorized) are identical, with the exception that sight-line distances and turning radii will be greater on motorized trails to accommodate the greater speeds and power associated with motorcycle use.

Final trail design and construction will take into consideration the local hydrology, soil types, cultural sites, and sensitive species that are listed, proposed or candidate for listing as threatened or endangered under the Endangered Species Act (ESA) within the area of the desired trail location. Known caves within the immediate vicinity of the proposed trail routes will continued to be managed by the USFS to protect culturally significant sites and follow U.S. Fish and Wildlife Service white nose syndrome protocols for bat populations that may frequent the caves. Trail designers will also identify sources of erosion, assess the potential impacts, and ensure that water and wind will not adversely affect the intended travel way.

4.3. Layout

The trail system has been laid out as a standalone recreation system for both motorized and non-motorized users in the Superior region. The trail system has been designed to deliberately limit AZNST tie-ins to already-designated locations in an effort to avoid additional unplanned pressures on AZNST usage.

The trail layout is designed to encourage the use of the proposed trail system while discouraging the use of the existing unauthorized trails and the creation of new unauthorized trails. The is accomplished through two primary approaches: signage placement and route design. First, signs will be strategically placed at trail heads to indicate the authorized paths and reinforce good trail stewardship by stressing the importance of staying on designated trails. Signs will also be placed as a deterrent, along with boulders, railings, etc., at unauthorized access points to discourage off-trail usage. Second, the trail route has been located such that turns in the trail (a common point where unauthorized trail usage occurs) will be placed adjacent to features that will serve as natural deterrents to off-trail use, such as large boulders, steep inclines or drop-offs, etc.

Three staging areas are planned on TNF lands (**Figure 3**) totaling 2.9 acres of disturbance. These staging areas are strategically located to be close to desirable recreation areas while also being accessible to passenger vehicles and close enough to Superior to encourage visitor use of the town.

Table 4 provides a summary of the of trail lengths segregated by trail type. Motorized trails include two track routes appropriate for four-wheeled vehicles and single-track routes appropriate for off-highway motorcycles. Non-motorized trails are proposed single-track routes that are intended for hikers, cyclists, and equestrians.

Table 4. New Trails Proposed on TNF Lands

Trail Type	Trail Length (miles)
Motorized (two track)*	14.7
Motorized (single track)	28.7
Non-Motorized	25.6
TOTAL	**69.0**

* Existing unauthorized two-track trails

The layout of existing trails on private land with the potential to be connected to the proposed network on TNF lands are not included in the estimated trail lengths, as private trails are not included in this plan unless an easement already exists or the land owner has agreed to grant an easement for the trail.

4.4. Construction

Most proposed trail construction within the lowlands of the Project Area (in the northeast portion) will consist of improvements to existing unauthorized two-track roads to reduce ongoing erosion and increase public safety. Redundant existing roads will be obliterated and reclaimed to the extent possible. The construction of one new non-motorized single-track trail and three trailhead parking areas are proposed within this section (**Figure 2**).

Typical activities associated with the construction of the new trail alignments will include shaping the thin soil layer where present and moving and/or reducing the sizes of boulders where they conflict with the intended users. Where possible, boulders and rock ledges will be incorporated into the trail alignments in accordance with the skill level of the anticipated users. Vegetation along proposed new single track alignments will be pruned to an approximate height of 10 feet and an approximate width of 6 to 8 feet to allow sufficient space for users to pass in opposite directions.

The bulk of construction will be done manually by volunteer crews, including youth, veteran, and ancestral lands crews, during the cooler months of the year. Most of the new trails will be constructed in the upland areas on top of solid rock. Manual construction activities will include shaping the thin soil layer where possible, moving boulders out of the planned trail route, and breaking rock to allow for passage where necessary. Some rocks and rock ledges will be preserved to provide a more challenging terrain for bicyclists.

Where necessary, professional operators will use mechanized equipment for trail construction. This will likely be limited primarily to the lowlands along the northern extent of the Project. In these cases (and where feasible) a SWECO trail dozer and mini excavator (or equivalent) would be used to construct the trail. Construction will proceed in phases.

The majority of new motorized trails will be for single-track (motorcycle) use only.[4] Design and construction standards will be essentially the same as for non-motorized use trails. Because of the greater speed and power associated with motorcycle use, sight-line distances, turning radii and switchback construction will all be adjusted accordingly.

4.5. Maintenance

Sustainable trail design and construction are being applied from the outset to minimize trail maintenance. As a result, most of the maintenance is anticipated to consist of pruning vegetation and maintaining drainage crossings. Unusually severe weather events may require more intensive maintenance and possible trail reconstruction.

[4] Approximately 3.2 miles of existing unauthorized trails are two track.

The success of numerous volunteer groups, such as the Arizona Trail Association (which maintains the AZNST), illustrates the fact that non-profit organizations can provide ongoing maintenance for recreational trails. It is anticipated that at least one such organization will be formed to recruit, train, and manage trail stewards and to raise funds for major repair projects.

4.6. Funding

It is anticipated that all final design and construction costs will be provided by at least one dedicated non-profit organization with additional funding provided by other entities. Construction and maintenance work will be conducted mainly by volunteers, such as youth, veteran, and ancestral lands volunteer crews. The bulk of construction expenses will come from the development of the final design and field layout by professional contractors, and the professional crews needed for more challenging trail sections. Possible funding sources include Resolution as well as grants, donations, and special organized events.

4.7. Trail Benefits

The trail is anticipated to provide benefits to the local economy in the form of long-term sustainable recreation and ecotourism, to reduce resource degradation from unauthorized trail use, and to better employ the currently underdeveloped recreational opportunities of National Forest lands located in proximity to a major metropolitan area.

The economic impacts that outdoor recreation provide to rural communities are well documented, and it is anticipated that development of the Project will be no exception for Superior, Arizona. Because the Project contains such a diverse range of scenic terrain within a relatively small area, it has the potential to become a popular destination for the growing number of outdoor recreation enthusiasts not only from the greater Phoenix area but also from across the country. In order to encourage visitors to use the town as a starting point, the Project includes the extension of an existing trail from town to the Picketpost trailhead on the Arizona National Scenic Trail (**Figure 2**), thereby providing a direct non-motorized connection to the Project Area. It is anticipated that the local business community will promote and participate in volunteer trail construction and maintenance efforts. The phasing of Project construction will allow for existing businesses to adapt to an expanding clientele and for new businesses to take advantage of new opportunities.

Developing a planned trail with appropriate signage and design elements will reduce the impacts to soil erosion, wildlife, plant life, and riparian habitat that the area is currently experiencing from the haphazard and unauthorized trail use that is occurring due to the lack of a planned system. The plan has identified sensitive resources and designed the trail system to avoid or minimize impacts to these resources.

The Group was developed specifically to ensure the trail system plan is one that meet the interests of the current users in a sustainable way that is in line with USFS management priorities. As a result, the proposed Project provides recreation opportunities currently unavailable in this location that are of interest to potential users. Furthermore, the Project's proximity to a major metropolitan area will facilitate access to these resources to in a more deliberate and environmentally sustainable way.

The proposed plan addresses ongoing management concerns for the TNF while providing a service and recreation opportunities that are currently underdeveloped to the local and regional communities, creating long-reaching benefits to the region.

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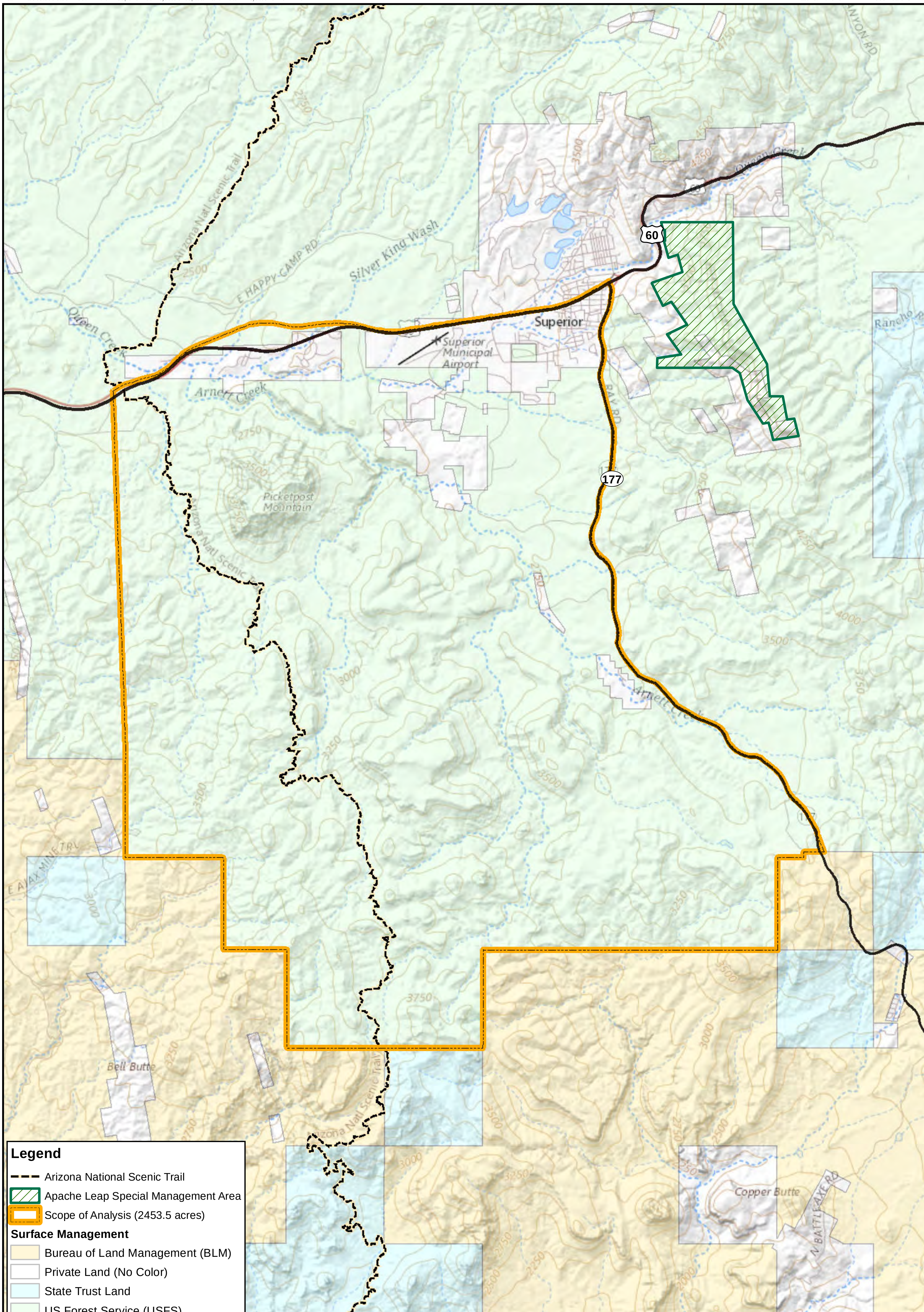
FIGURES



Scope of Analysis within:
T2S, R11-13E, and T3S, R12E,
Pinal County, Arizona,
Data Source: AZ Trail Association and
Surface Management: BLM 2018, WRI modified 2018
Image Source: ArcGIS Online USGS National Map

WestLand Resources

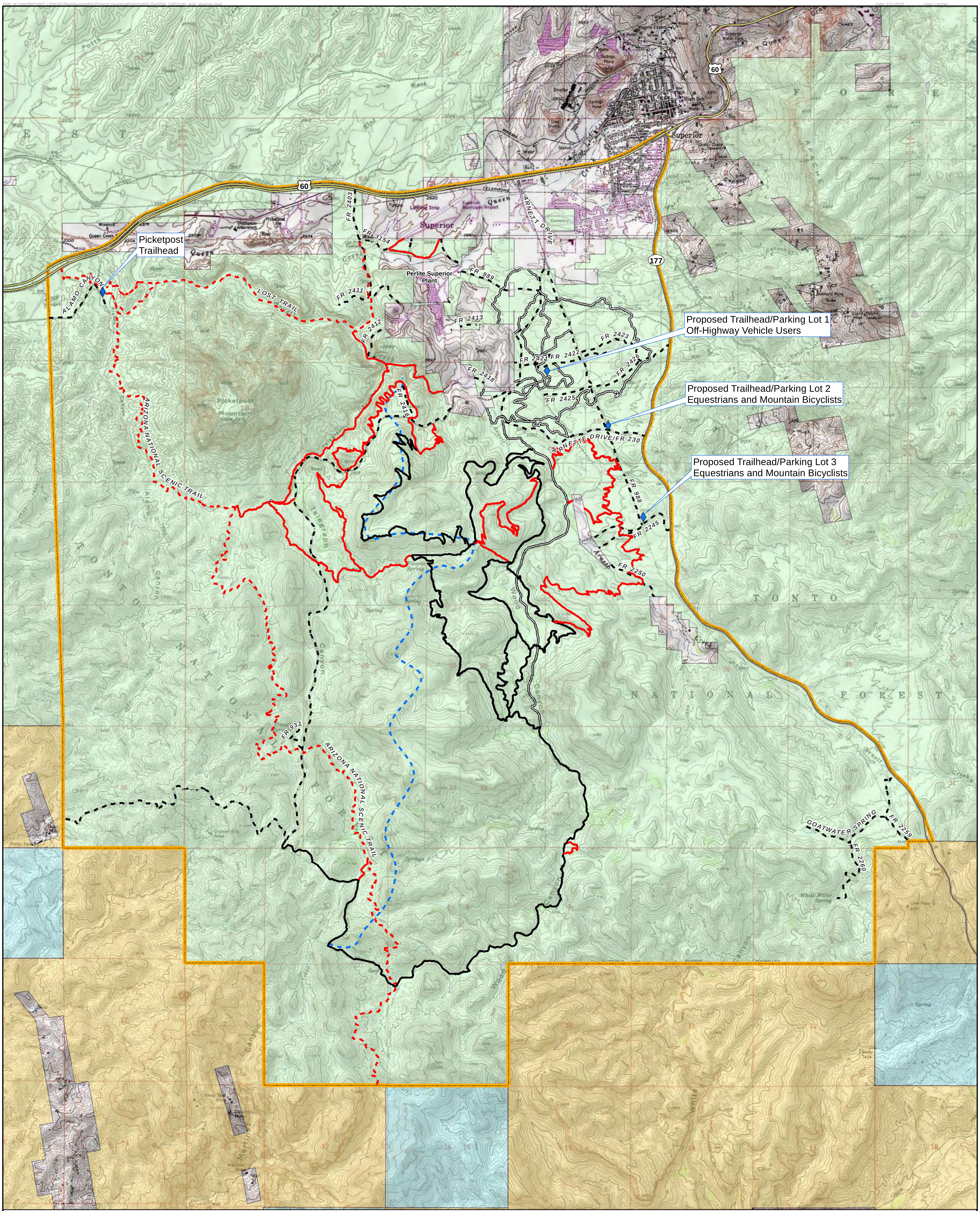
N

0 2,500 5,000 Feet

0 1,000 2,000 Meters

RECREATION USER GROUP
SUPERIOR, AZ
Conceptual Plan

PROJECT OVERVIEW
Figure 1



Scope of Analysis within:
T2S, R11-13E, and T3S, R12E,
Pinal County, Arizona,
Mesa USGS 1:100,000 USGS Quadrangle
Data Source: Surface Management (BLM 2018, WRI Modified 2018),
Recreation User Group (RUG)
Road Classification: ArcGIS Online, USA Major Roads

WestLand Resources

N

0 1,250 2,500 Feet

0 500 1,000 Meters

Legend

Recreation Use Trail

- Proposed Trail, Motorized (Single Track)
- Existing Forest Road, Motorized
- Proposed Road, Motorized
- Existing Trail, Non-Motorized
- Proposed Trail, Non-Motorized
- Telegraph Canyon/Wood Canyon Ridgeline

Road Classification

- Other Major Road
- Secondary Road
- Important Local Road
- Scope of Analysis (2453.5 acres)

Surface Management

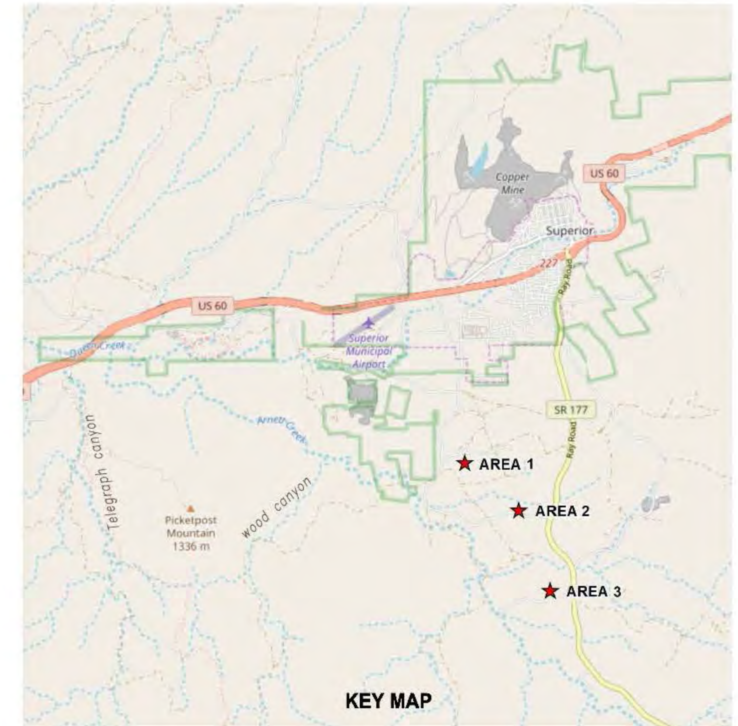
- Bureau of Land Management (BLM)
- Private Land (No Color)
- State Trust Land
- US Forest Service (USFS)

RECREATION USER GROUP
SUPERIOR, AZ
Conceptual Plan

TRAIL DESIGN
Figure 2

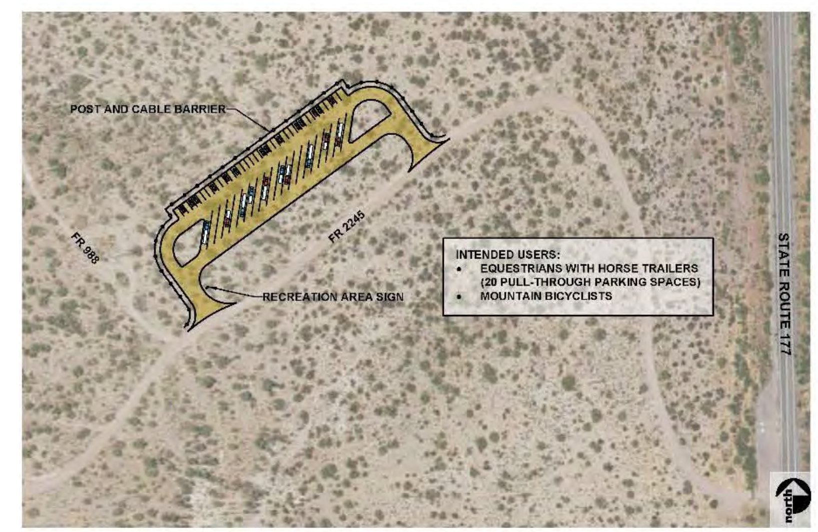
1 TRAILHEAD PARKING AREA (FOREST ROADS 2421 & 2422) : OFF-HIGHWAY VEHICLES

SCALE: 1" = 200'



2 TRAILHEAD PARKING AREA (ARNETT DRIVE/ FOREST ROAD 230) : EQUESTRIAN & MOUNTAIN BICYCLIST

SCALE: 1" = 200'



3 TRAILHEAD PARKING AREA (FOREST ROAD 2245) : EQUESTRIAN & MOUNTAIN BICYCLIST

SCALE: 1" = 200'

WestLand Resources Inc.
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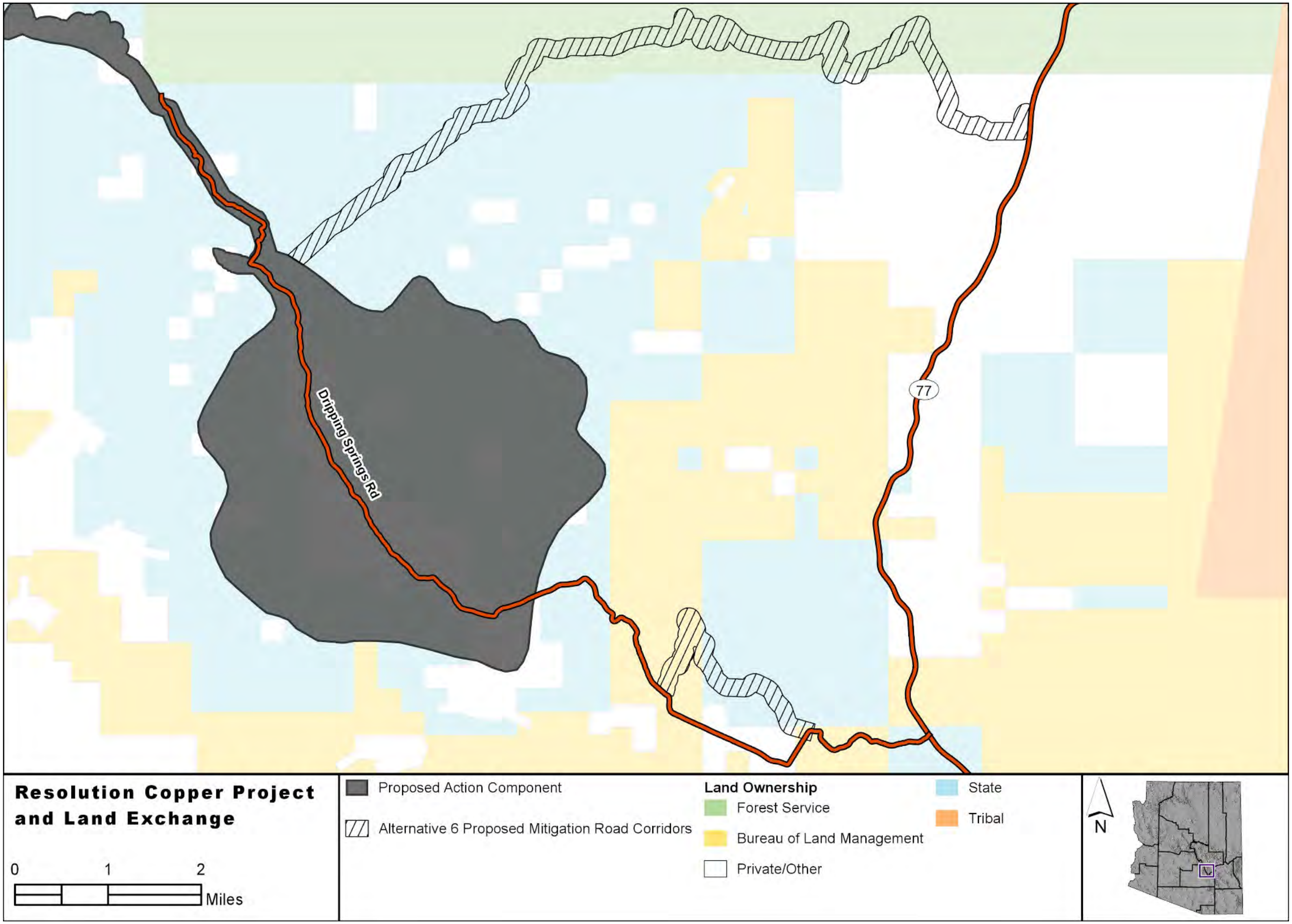
RECREATION USER GROUP
SUPERIOR, AZ
Conceptual Plan

TRAILHEAD PARKING AREAS

Figure 3



Dripping Springs Rd
77
Resolution Copper Project
and Land Exchange
0
1
2
Miles
Proposed Action Component
Alternative 6 Proposed Mitigation Road Corridors
Land Ownership
Forest Service
Bureau of Land Management
Private/Other
State
Tribal
N

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APPENDIX K. SUMMARY OF CONTENT OF RESOURCE ANALYSIS PROCESS MEMORANDA

Analysis Process Memoranda

Overview of Process

Under the National Environmental Policy Act of 1969, as amended (NEPA), the U.S. Department of Agriculture Forest Service (Forest Service) is responsible for taking a "hard look" at potential impacts from the Resolution Copper Project and Land Exchange (project) using the best available information and science. The project involves multiple facilities, multiple phases, a large and diverse geographic area, and several exceptionally complex analyses, including subsidence modeling, groundwater modeling, and geochemical modeling. A substantial amount of detailed documentation is necessary to describe the analysis approaches, assumptions, and results.

At the same time, the Forest Service has strived to make the environmental impact statement (EIS) accessible and understandable, as is made clear in the Council on Environmental Quality (CEQ) regulations (emphasis added):

> 40 Code of Federal Regulations (CFR) 1502.2 – Implementation
>
> > To achieve the purposes set forth in §1502.1 agencies shall prepare environmental impact statements in the following manner:
> >
> > > (a) Environmental impact statements shall be *analytic rather than encyclopedic*.
> > >
> > > (b) Impacts shall be discussed in proportion to their significance. There shall be *only brief discussion of other than significant issues*. As in a finding of no significant impact, there should be only enough discussion to show why more study is not warranted.
> > >
> > > (c) Environmental impact statements shall be *kept concise and shall be no longer than absolutely necessary* to comply with NEPA and with these regulations. Length should vary first with potential environmental problems and then with project size.
>
> 40 CFR 1502.8 – Writing
>
> > Environmental impact statements shall be *written in plain language and may use appropriate graphics* so that decisionmakers and the public can readily understand them. Agencies should employ writers of clear prose or editors to write, review, or edit statements, which will be based upon the analysis and supporting data from the natural and social sciences and the environmental design arts.

To accomplish this balance, some details of the complex analysis have been left out of the EIS itself. These details are still available to the public in a series of memoranda, one for each resource in chapter 3. This is consistent with CEQ regulations:

> 40 CFR 1502.21 – Incorporation by reference
>
> > Agencies shall incorporate material into an environmental impact statement by reference when the effect will be to cut down on bulk without impeding agency and public review of the action. The incorporated material shall be cited in the statement and its content briefly described. No material may be incorporated by reference unless it is reasonably available for inspection by potentially interested persons within the time allowed for

comment. Material based on proprietary data which is itself not available for review and comment shall not be incorporated by reference.

The purpose of this appendix is to summarize the available memoranda and the contents in each. Table K-1 shows a summary of the available process memoranda. Each subsection briefly summarizes the topics included in the individual process memoranda.

Table K-1. Summary of analysis process memoranda

Resource	Reference
Geology, Minerals, and Subsidence	(Newell and Garrett 2018b)
Soils and Vegetation	(Newell 2018h)
Noise and Vibration	(Newell 2018d)
Transportation and Access	(Newell 2018i)
Air Quality	(Newell and Garrett 2018a)
Water Resources	(Newell and Garrett 2018d)
Wildlife	(Newell 2018k)
Recreation	(Newell 2018e)
Public Health and Safety	(Newell and Garrett 2018c)
Scenic Resources	(Newell 2018f)
Cultural Resources	(Newell 2018a)
Socioeconomics	(Newell 2018g)
Tribal Values and Concerns	(Newell 2018j)
Environmental Justice	(Newell 2018b)
Livestock and Grazing	(Newell 2018c)

Geology, Minerals, and Subsidence

The contents of the process memorandum that supports the "Geology, Minerals, and Subsidence" section of chapter 3 includes the following:

- Detailed Information Supporting EIS Analysis
    - Resource Analysis Area
    - Analysis Methodology
        - Approach – Baseline Data
        - Approach – Subsidence Modeling
        - Approach – Vetting of Geologic and Subsidence Modeling
        - Status of Geology and Subsidence Workgroup
    - Detailed Information on Geologic Framework and Geologic Units
        - Regional Geology
        - Regional Geologic Units
        - Structural Geology and Faults

        - Local Geology of Mine Area and Associated Infrastructure
        - Mineral Deposit
        - Tailings Storage Facility Area – Alternatives 2 and 3
        - Tailings Storage Facility Area – Alternative 4
        - Tailings Storage Facility Area – Alternative 5
        - Tailings Storage Facility Area – Alternative 6
        - East Plant Site
        - West Plant Site
        - Tunnels between East and West Plant Sites
        - Magma Arizona Railroad Company (MARRCO) Corridor
        - Filter/Loadout Facility
        - Pipeline Corridors
- Regulations, Laws, and Guidance
- Key Documents and References Cited for Geology, Minerals, and Subsidence

Soils and Vegetation

The contents of the process memorandum that supports the “Soils and Vegetation” section of chapter 3 includes the following:

- Detailed Information Supporting EIS Analysis
    - Resource Analysis Area
    - Analysis Methodology and Selected Outcomes
        - Soils
        - Revegetation
        - Vegetation Communities, Noxious Weeds, and Special Status Plant Species
        - Concern for Impacts to Stability from Revegetation
        - Previous and Existing Disturbance
        - Assessment of Need to Collect Additional Information
- Regulation, Laws, and Guidance
- Key Documents and References Cited for Soils and Vegetation
- Appendix 1: Additional Information for Vegetation Communities Affected Environment
- Appendix 2: Detailed Soil Analysis Results

Noise and Vibration

The contents of the process memorandum that supports the “Noise and Vibration” section of chapter 3 includes the following:

- Detailed Information Supporting EIS Analysis
    - Resource Analysis Area
    - Analysis Methodology
        - Noise Modeling
        - Non-Blasting Noise Modeling
        - Blasting Noise Modeling
        - Blasting Vibration Modeling
        - Non-Blasting Vibration Modeling
        - Noise and Vibration Metrics
- Regulation, Laws, and Guidance
- Key Documents and References for Noise and Vibration

Transportation and Access

The contents of the process memorandum that supports the "Transportation and Access" section of chapter 3 includes the following:

- Detailed Information Supporting EIS Analysis
    - Resource Analysis Area
    - Analysis Methodology
- Regulation, Laws, and Guidance
- Key Documents and References Cited for Transportation and Access

Air Quality

The contents of the process memorandum that supports the "Air Quality" section of chapter 3 includes the following:

- Detailed Information Supporting EIS Analysis
    - Resource Analysis Area
        - Temporal Analysis
        - Spatial Analysis Area
    - Analysis Methodology
        - Standard Source/Distance (Q/D) Analysis for Class I Areas
        - Ambient Air Quality Monitoring
        - Conformity Analysis for Alternatives 5 and 6 for PM_{10} Non-Attainment Area
        - Emissions of Hazardous Air Pollutants
        - Lead Emissions
        - Secondary $PM_{2.5}$ and Ozone Formation

        - Estimate of Indirect Emissions
        - Health Based Risk Assessment Screening
- Regulation, Laws, and Guidance
- Key Documents and References Cited for Air Quality

Water Resources

The contents of the process memorandum that supports the "Water Resources" section of chapter 3, which has three subsections, includes the following:

GROUNDWATER QUANTITY AND GROUNDWATER-DEPENDENT ECOSYSTEMS

- Detailed Information Supporting EIS Analysis – Groundwater Quantity and Groundwater-Dependent Ecosystems
    - Resource Analysis Area
        - Temporal Analysis
        - Spatial Analysis Area
    - Analysis Methodology
        - Status of Groundwater Modeling Workgroup
        - Detailed Modeling Results for GDEs Summarized in DEIS
        - Assumption of Hydrologic Connection
        - Assessment of Need to Collect Additional Information
        - Rationale for Use of East Salt River Valley Model for Desert Wellfield
        - Subsidence Related to Groundwater Withdrawal – Desert Wellfield
        - Subsidence Related to Groundwater Withdrawal – East Plant Site
        - Inability to Analyze Individual Wells
        - Available Groundwater in East Salt River Valley
        - Full Detail for Tailings Water Balances
        - Percent Contribution of Spring DC6.6W to Devil's Canyon
    - Regulation, Laws, and Guidance – Groundwater Quantity
    - References and Key Documents – Groundwater Quantity and Groundwater Modeling

GROUNDWATER AND SURFACE WATER QUALITY

- Detailed Information Supporting EIS Analysis – Groundwater and Surface Water Quality
    - Resource Analysis Area
        - Temporal Analysis
        - Spatial Analysis Area
    - Analysis Methodology
        - Details of Geochemistry Workgroup

        - Assimilative Capacity Calculations
        - Reduced Assimilative Capacity from Reductions in Runoff
        - Existing Groundwater Quality – Frequency of Samples with Concentrations above Standards
        - Evolution of the Fully-Lined Alternative
        - Estimate of Seepage from a Fully-Lined Facility
        - Evaluation of Filtered Tailings at Other Tailings Locations
        - Consideration of Consolidation of Tailings in Seepage Analysis
        - Comparison of Alternative 5 and 6 surface water samples to additional Gila River water quality samples
        - Calculations of Pollutant Loading for Constituents of Concern from Each Alternative
        - Analysis for Technologically Enhanced Naturally Occurring Radioactive Materials (TENORM)
- Regulation, Laws, and Guidance – Groundwater and Surface Water Quality
- Key Documents and References Cited for Groundwater and Surface Water Quality

SURFACE WATER QUANTITY

- Detailed Information Supporting EIS Analysis – Surface Water Quantity
    - Resource Analysis Area
    - Analysis Methodology
        - Surface Water Effects – Modeling Approaches
        - Floodplains and Lack of Available Data
        - Detailed Floodplain Impacts
        - Detailed Wetland Impacts
        - Acreage Differences
        - Differences in Stormwater and Erosion Control between Alternatives
            - General Sediment and Erosion Control Measures
            - East Plant Site Facility Stormwater Controls
            - West Plant Site Facility Stormwater Controls
            - Filter Plant and Loadout Facility Stormwater Controls
            - Alternatives 2 and 3 Tailings Storage Facility Stormwater Controls
            - Alternative 4 Tailings Storage Facility Stormwater Controls
            - Alternative 5 Tailings Storage Facility Stormwater Controls
            - Alternative 6 Tailings Storage Facility Stormwater Controls
        - Full Details of Streamflow Discharge-Duration-Frequency Analysis

- Regulation, Laws, and Guidance – Surface Water Quantity
- Key Documents and References Cited for Surface Water Quantity

Wildlife

The contents of the process memorandum that supports the "Wildlife" section of chapter 3 includes the following:

- Detailed Information Supporting EIS Analysis
    - Resource Analysis Area
    - Analysis Methodology
- Regulation, Laws, and Guidance
- Key Documents and References Cited for Wildlife
- Appendix A – Wildlife Screening Tables

Recreation

The contents of the process memorandum that supports the "Recreation" section of chapter 3 includes the following:

- Detailed Information Supporting EIS Analysis
    - Resource Analysis Area
    - Analysis Methodology
- Regulation, Laws, and Guidance
- Key Documents and References Cited for Recreation

Public Health and Safety

The contents of the process memorandum that supports the "Public Health and Safety" section of chapter 3, which has three subsections, includes the following:

TAILINGS AND PIPELINE SAFETY

- Detailed Information Supporting EIS Analysis – Tailings and Pipeline Safety
    - Resource Analysis Area
        - Temporal Analysis
        - Spatial Analysis Area
    - Analysis Methodology
        - Available Options for Breach Analysis
            - Empirical Method
            - Rheological and Energy Balance Methods
            - Advanced Modeling

        - Forest Service Chosen Methodology
        - Assessment of Need to Collect Additional Information
- Regulation, Laws, and Guidance – Tailings and Pipeline Safety
- Key Documents and References Cited for Tailings and Pipeline Safety

FUELS AND FIRE MANAGEMENT

- Detailed Information Supporting EIS Analysis – Fuels and Fire Management
    - Resource Analysis Area
    - Analysis Methodology
- Regulation, Laws, and Guidance – Fuels and Fire Management
- Key Documents and References Cited for Fuels and Fire Management

HAZARDOUS MATERIALS

- Detailed Information Supporting EIS Analysis – Hazardous Materials
    - Resource Analysis Area
    - Analysis Methodology
- Regulation, Laws, and Guidance – Hazardous Materials
- Key Documents and References Cited for Hazardous Materials

Scenic Resources

The contents of the process memorandum that supports the “Scenic Resources” section of chapter 3 includes the following:

- Detailed Information Supporting EIS Analysis
    - Resource Analysis Area
    - Analysis Methodology
        - Viewshed Analysis
        - Key Observation Points and Contrast Rating Analysis
        - Visual Simulation
        - Additional Detail for Scenery Resources in the Analysis Area
- Regulation, Laws, and Guidance
- Key Documents and References Cited for Scenic Resources
- Appendix A: Viewshed Analyses for each Alternative
- Appendix B: Contrast Rating Worksheets for Each Key Observation Point
- Appendix C: Visual Simulations

Cultural Resources

The contents of the process memorandum that supports the "Cultural Resources" section of chapter 3 includes the following:

- Detailed Information Supporting EIS Analysis
    - Resource Analysis Area
    - Analysis Methodology
        - Impact Indicators
- Regulation, Laws, and Guidance
- Key Documents and References Cited for Cultural Resources

Socioeconomics

The contents of the process memorandum that supports the "Socioeconomics" section of chapter 3 includes the following:

- Detailed Information Supporting EIS Analysis
    - Resource Analysis Area
    - Analysis Methodology
- Regulation, Laws, and Guidance
- Key Documents and References Cited for Socioeconomics

In addition, a key technical report was prepared by BBC Research and Consulting to document the details of the economic modeling and analysis, titled " Socioeconomic Effects Technical Report: Resolution Copper Mine Environmental Impact Statement," and dated November 12, 2018 (BBC Research and Consulting 2018).

Tribal Values and Concerns

The contents of the process memorandum that supports the "Tribal Values and Concerns" section of chapter 3 includes the following:

- Detailed Information Supporting EIS Analysis
    - Resource Analysis Area
    - Analysis Methodology
        - Impact Indicators
- Regulation, Laws, and Guidance
- Key Documents and References Cited for Tribal Values and Concerns

Environmental Justice

The contents of the process memorandum that supports the "Environmental Justice" section of chapter 3 includes the following:

- Detailed Information Supporting EIS Analysis
    - Resource Analysis Area
    - Analysis Methodology
- Regulation, Laws, and Guidance
- Key Documents and References Cited for Environmental Justice

Livestock and Grazing

The contents of the process memorandum that supports the "Livestock and Grazing" section of chapter 3, includes the following:

- Detailed Information Supporting EIS Analysis
    - Analysis Area
    - Analysis Methodology
        - Reduction in AUMs
- Regulation, Laws, and Guidance
- Key Documents and References Cited for Livestock and Grazing

APPENDIX L. DETAILED HYDROGRAPHS DESCRIBING IMPACTS ON GROUNDWATER-DEPENDENT ECOSYSTEMS

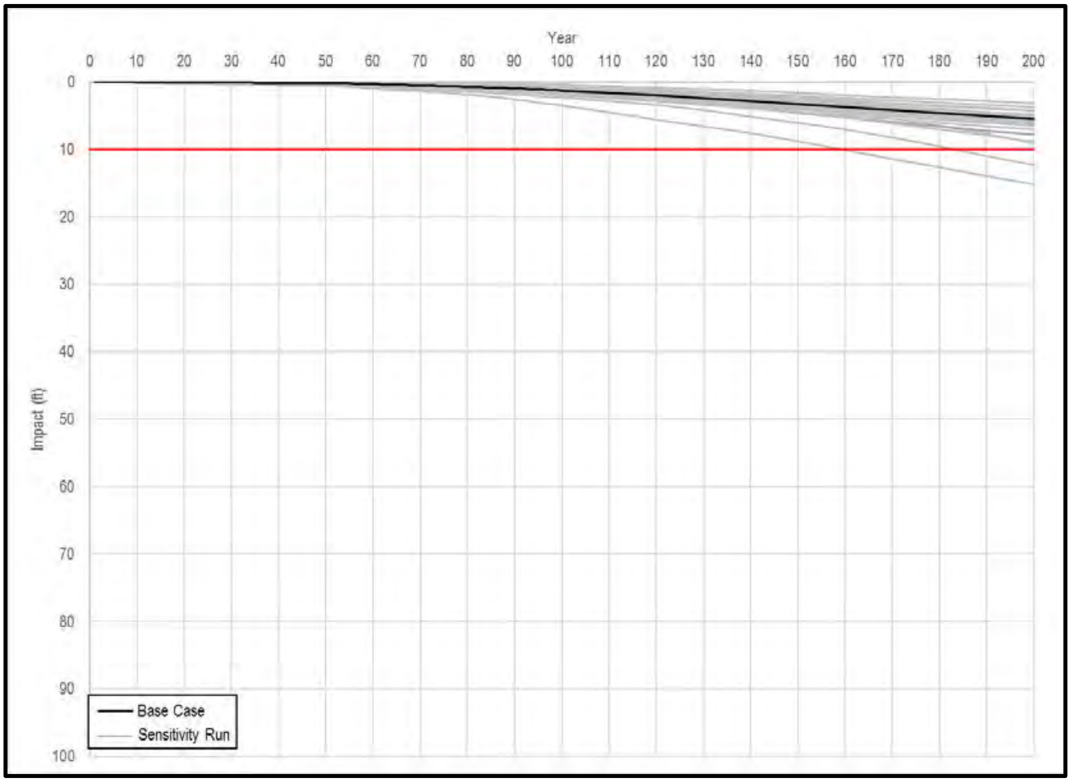

Figure L-1. Queen Creek – Flowing reach from km 17.39 to km 15.55

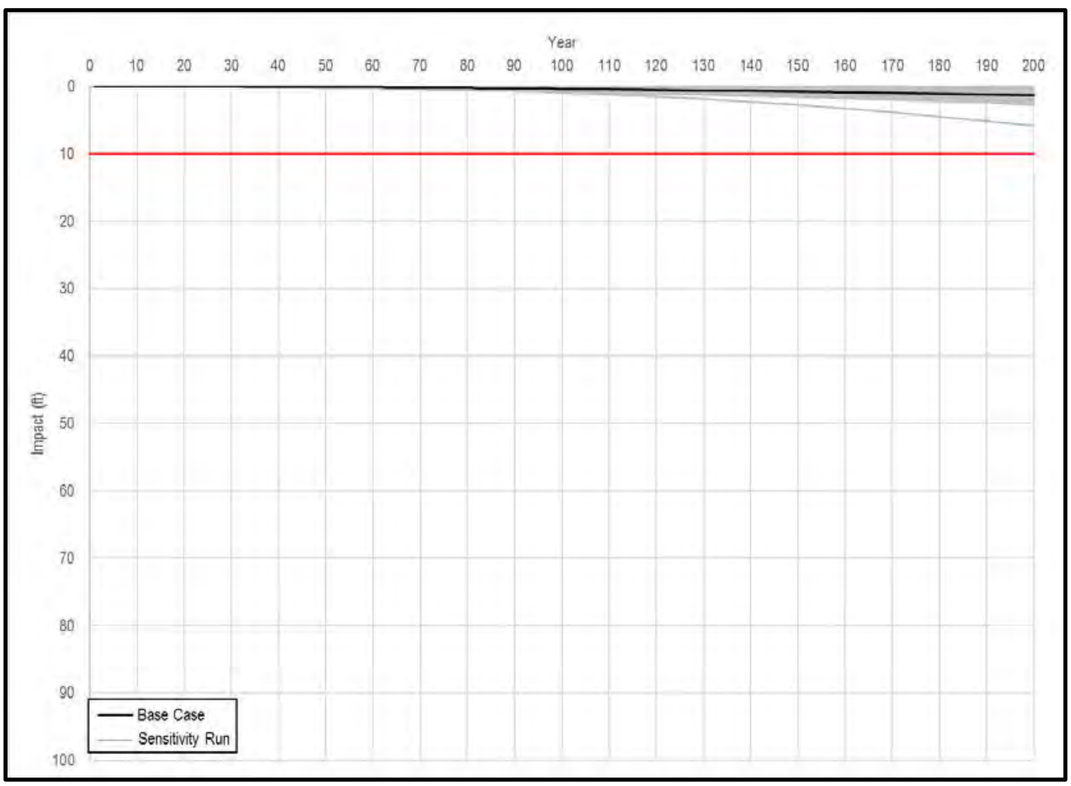

Figure L-2. Arnett Creek (from Blue Spring to confluence with Queen Creek). Specific location: AC-12.49

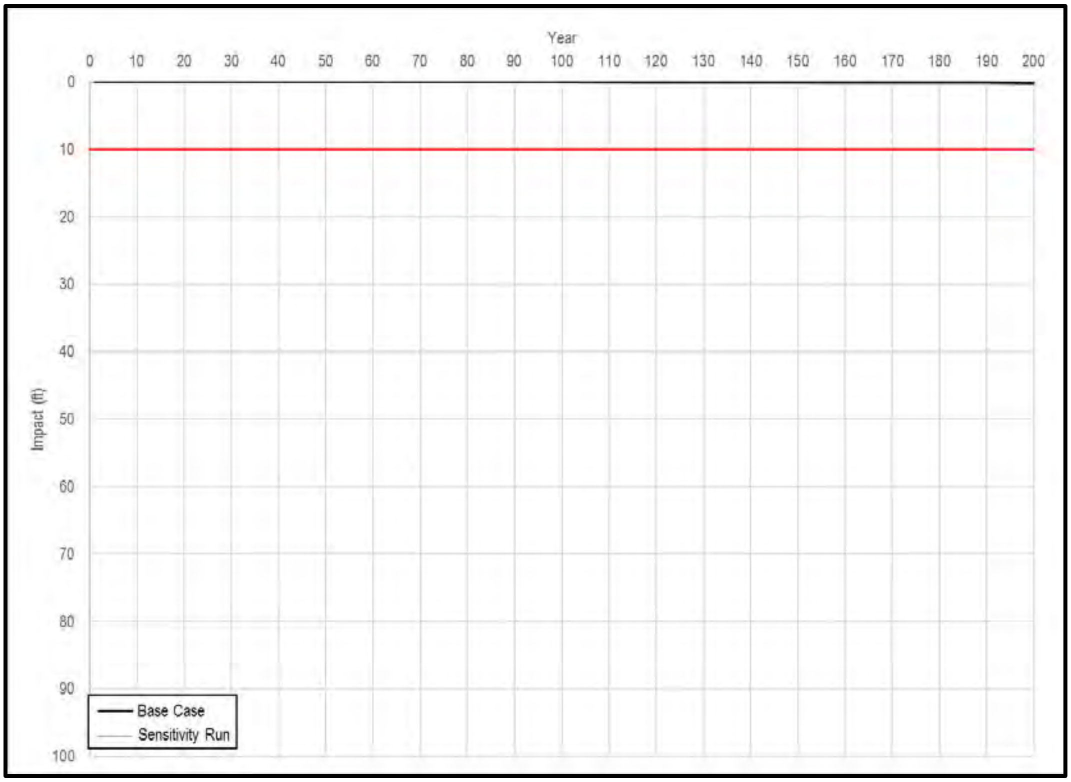

Figure L-3. Arnett Creek (from Blue Spring to confluence with Queen Creek). Specific location: AC-4.54

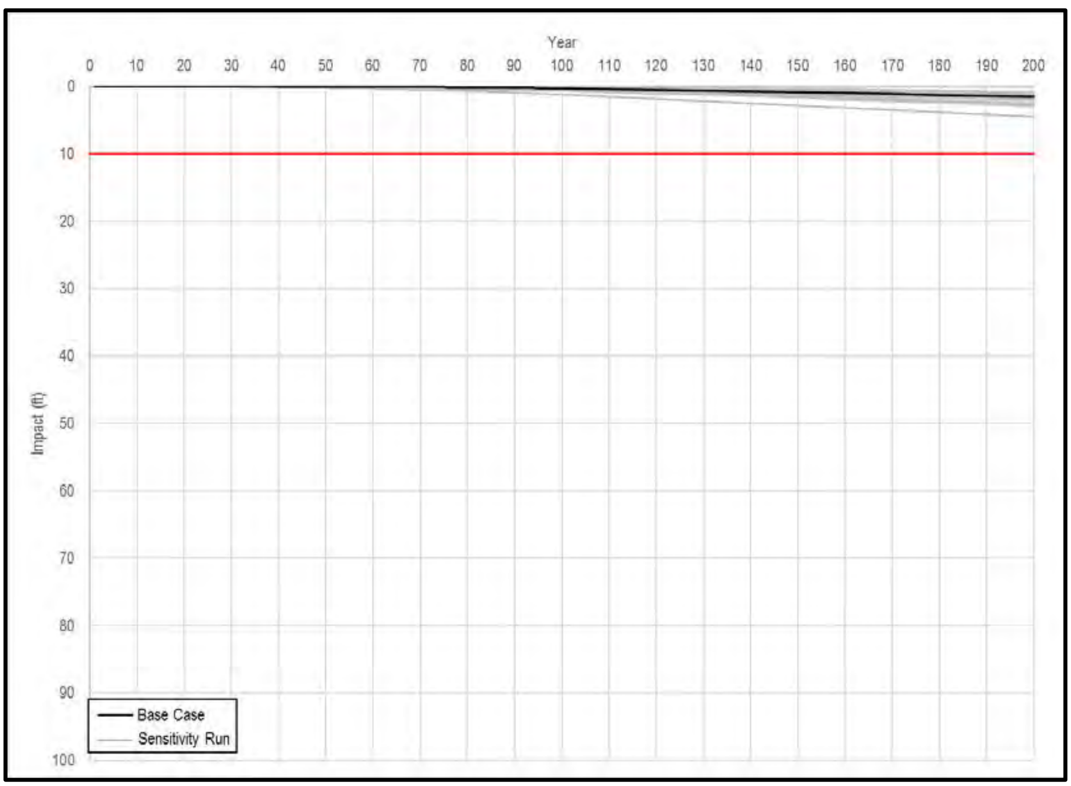

Figure L-4. Telegraph Canyon (near confluence with Arnett Creek)

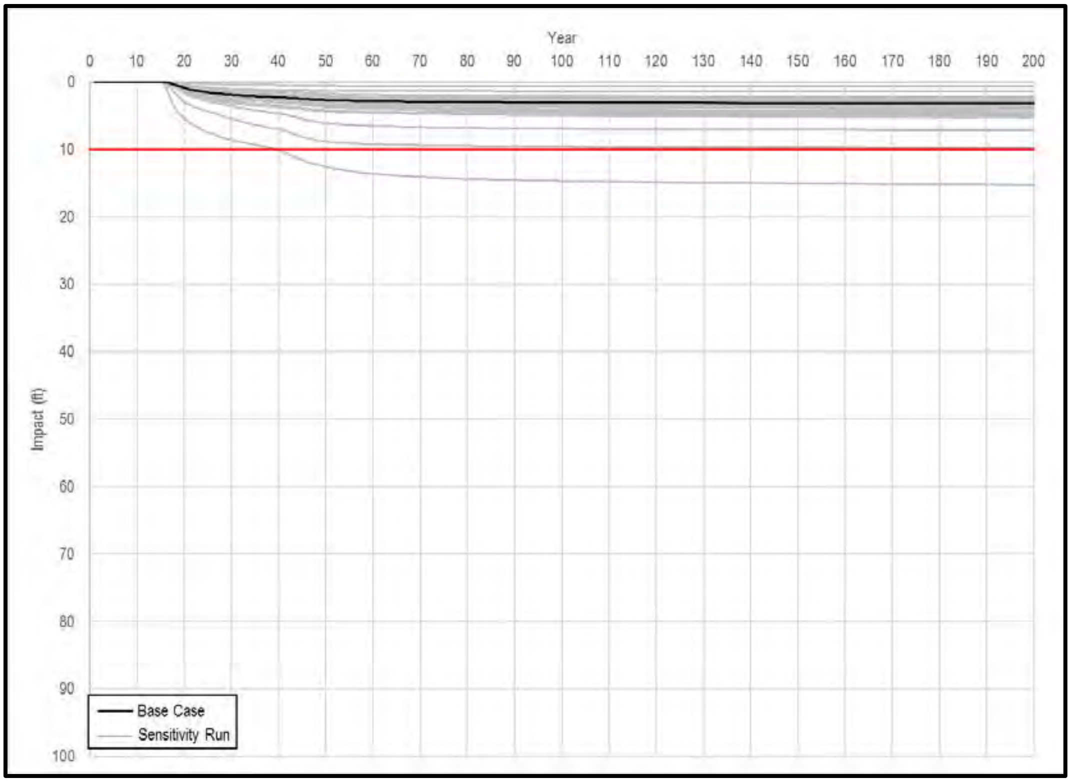

Figure L-5. Middle Devil's Canyon (from km 9.3 to km 6.1). Specific location: DC-8.8C

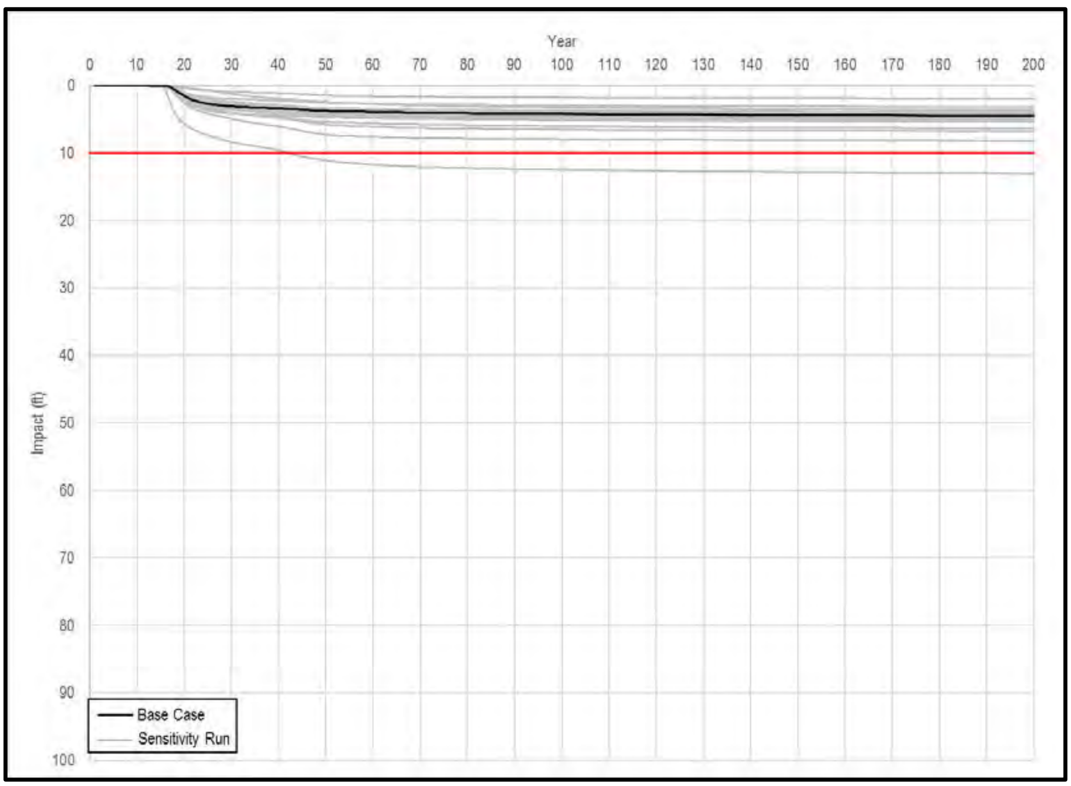

Figure L-6. Middle Devil's Canyon (from km 9.3 to km 6.1). Specific location: DC-8.2W

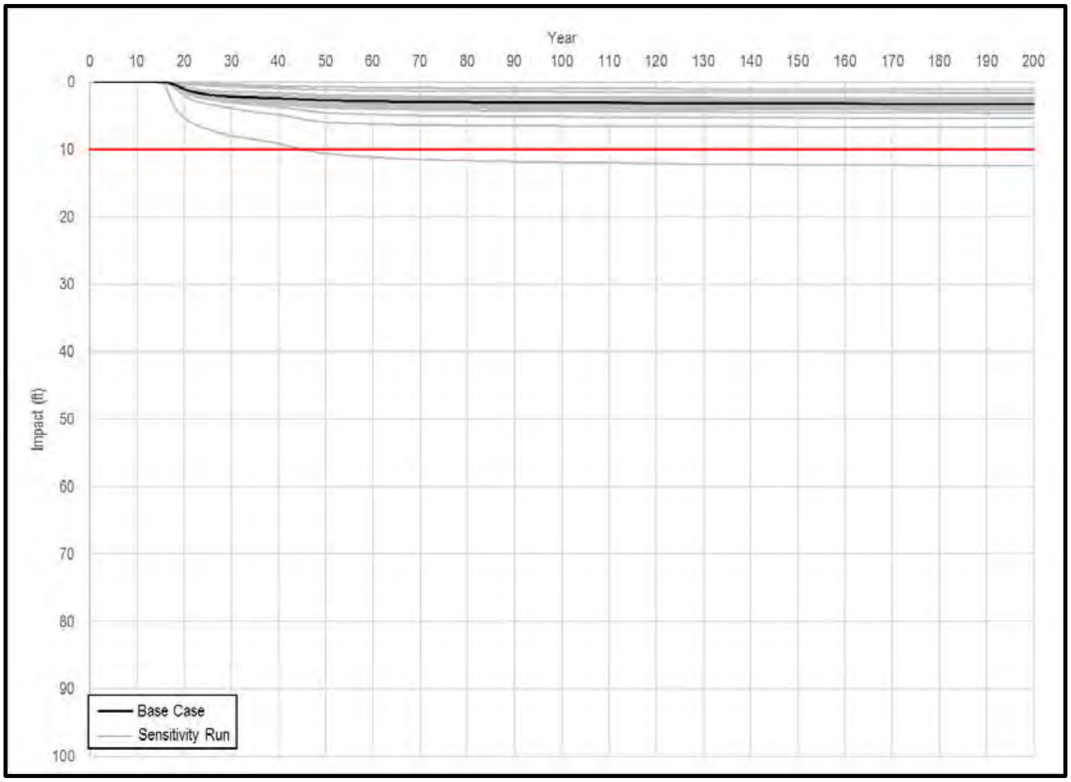

Figure L-7. Middle Devil's Canyon (from km 9.3 to km 6.1). Specific location: DC-8.1C

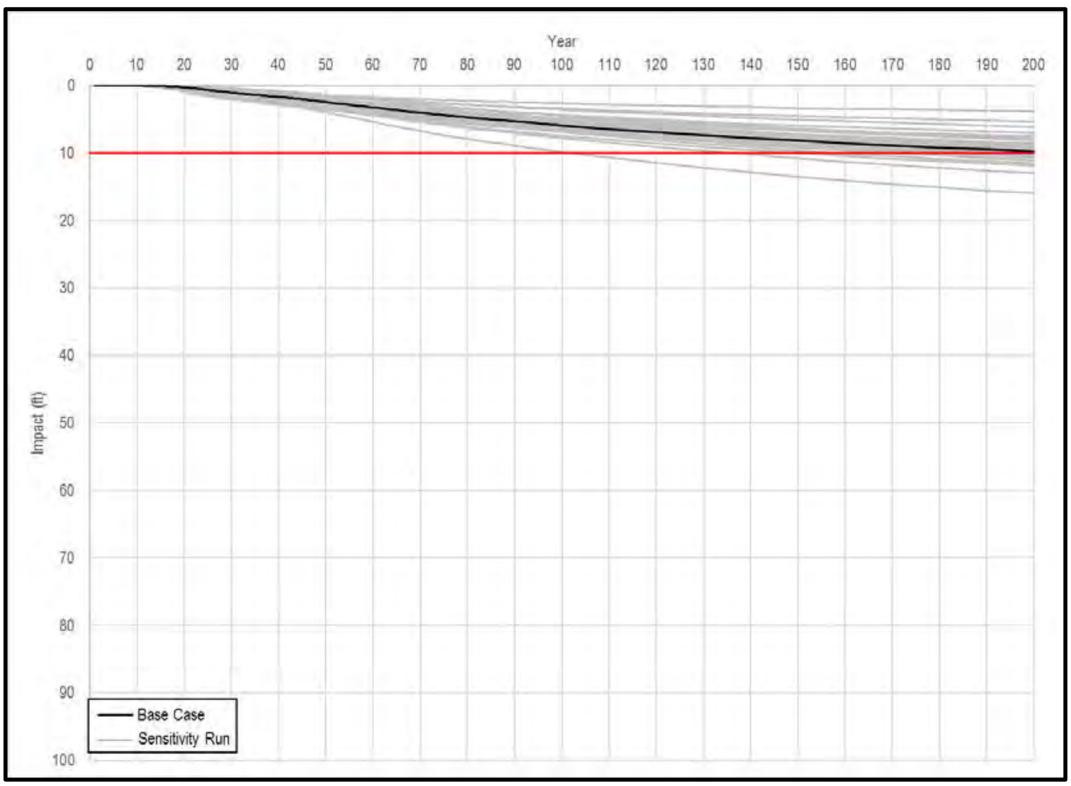

Figure L-8. Middle Devil's Canyon (from km 9.3 to km 6.1). Specific location: DC-6.6W

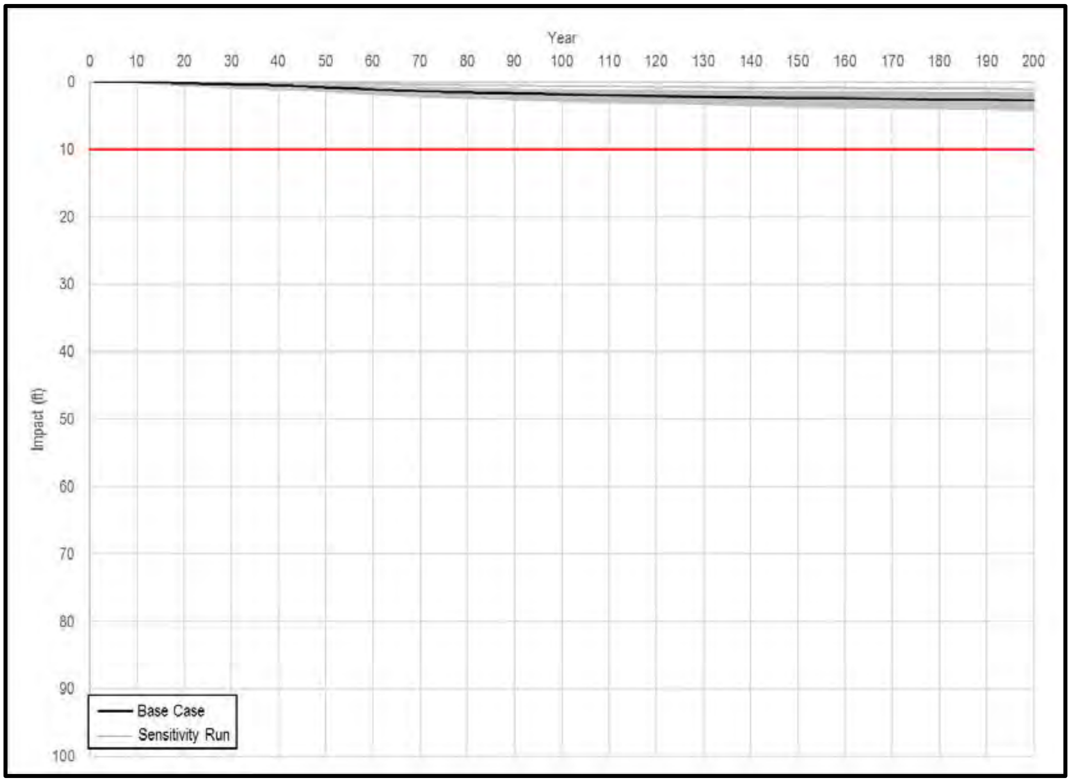

Figure L-9. Middle Devil's Canyon (from km 9.3 to km 6.1). Specific location: DC-6.1E

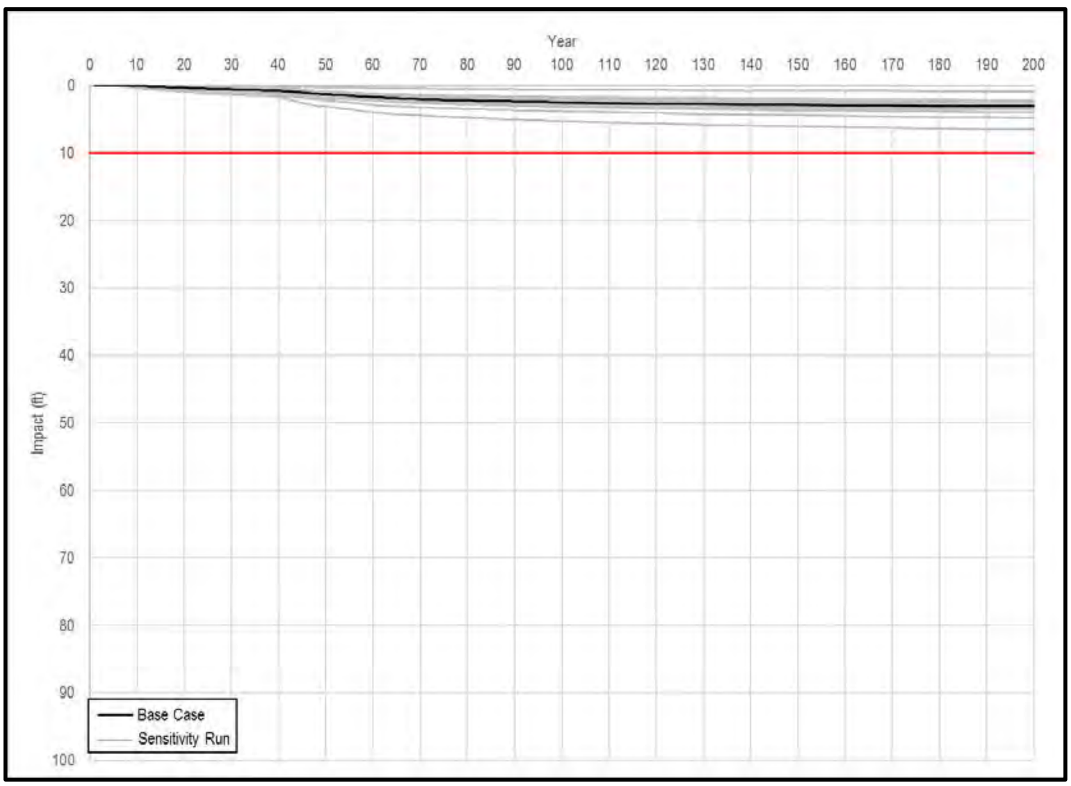

Figure L-10. Lower Devil's Canyon (from km 6.1 to confluence with Mineral Creek). Specific location: DC-5.5C

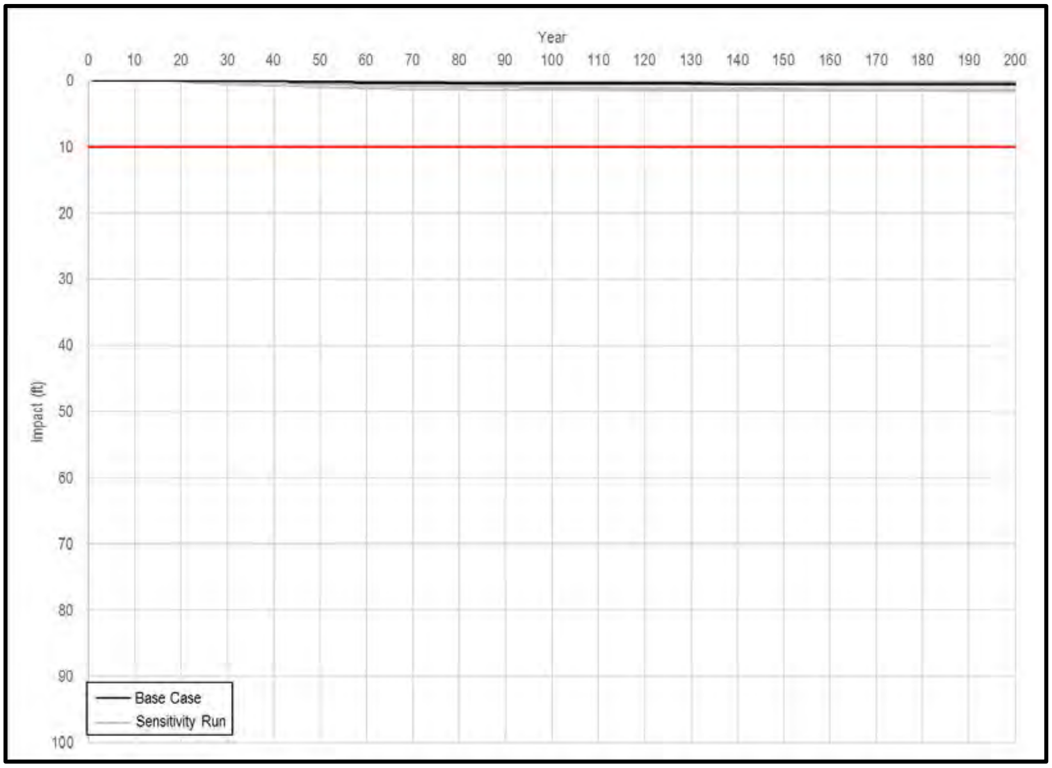

Figure L-11. Lower Devil's Canyon (from km 6.1 to confluence with Mineral Creek). Specific location: DC-4.1E

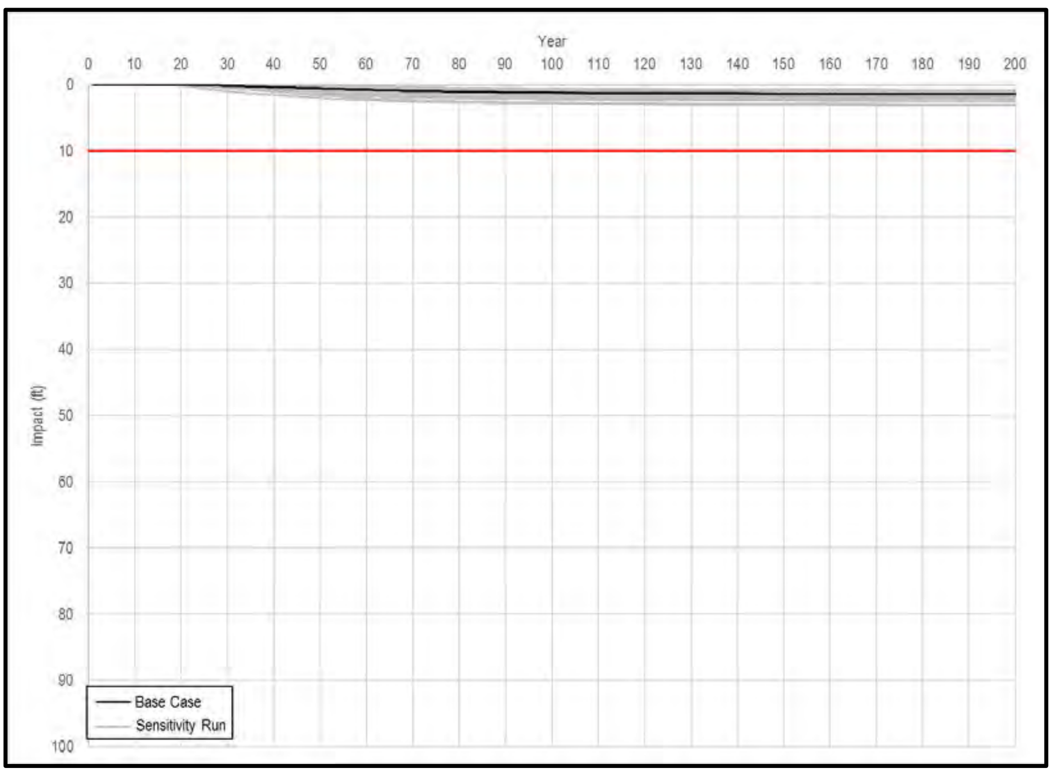

Figure L-12. Mineral Creek (from Government Springs [km 8.7] to confluence with Devil's Canyon). Specific location: MC-6.9

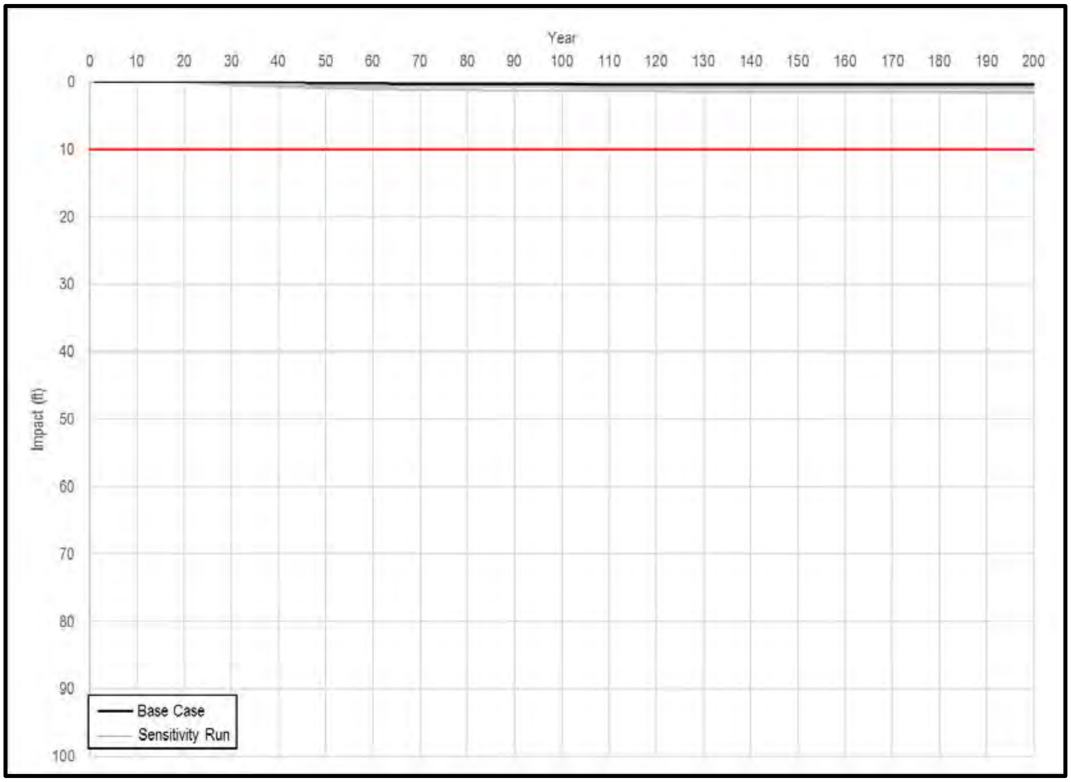

Figure L-13. Mineral Creek (from Government Springs [km 8.7] to confluence with Devil's Canyon). Specific location: Lower Mineral Creek

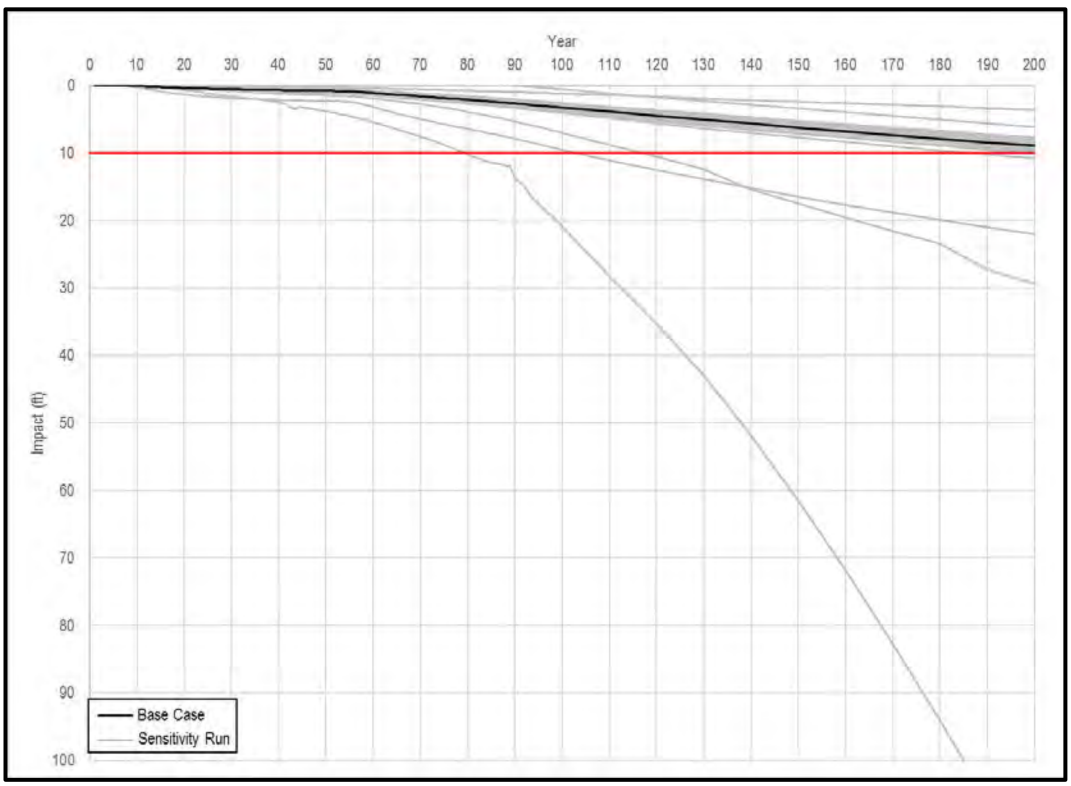

Figure L-14. Bitter Spring

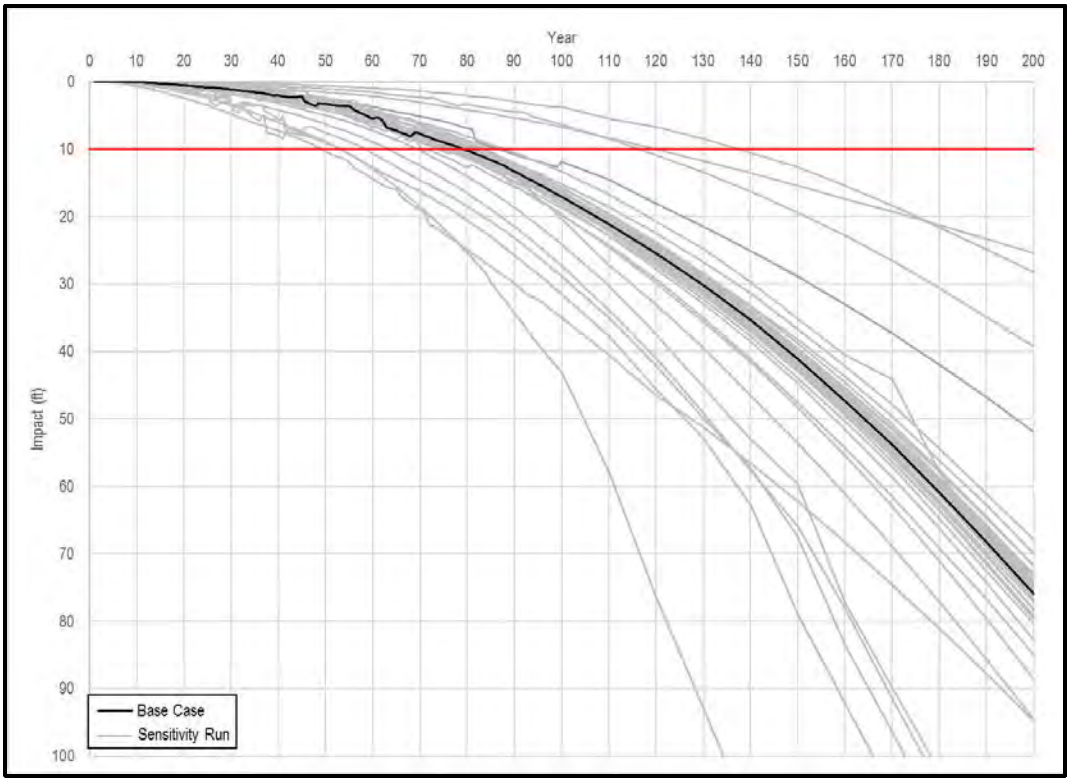

Figure L-15. Bored Spring

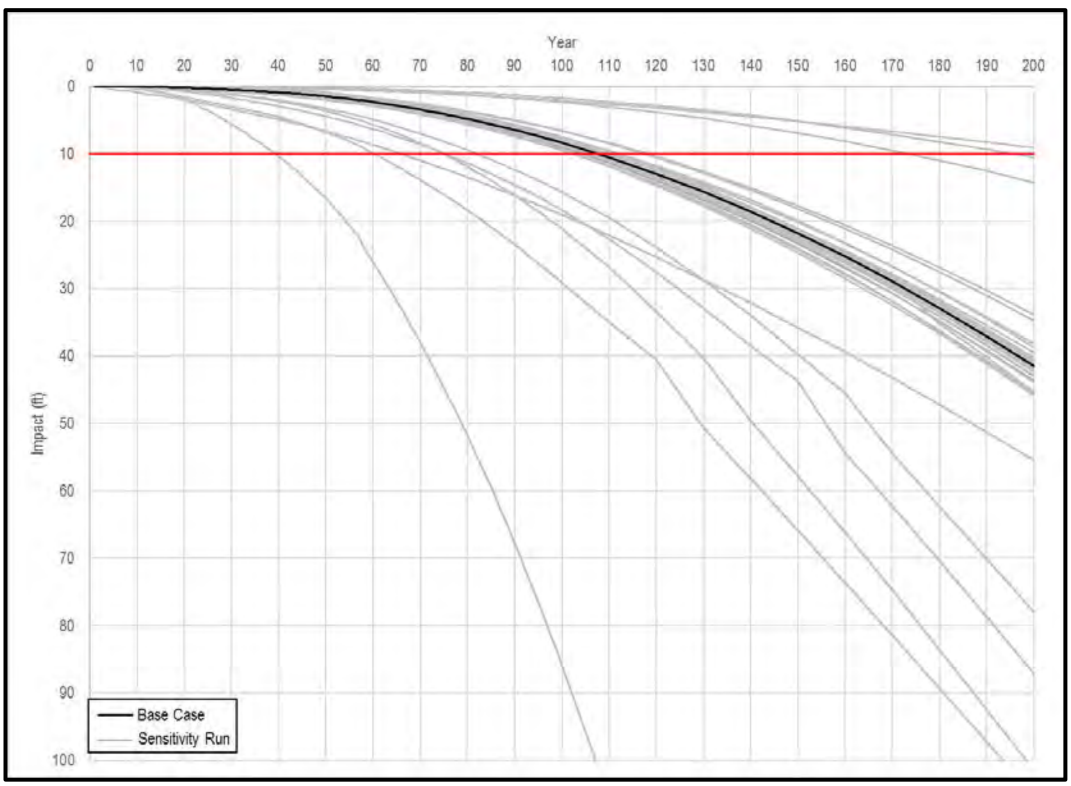

Figure L-16. Hidden Spring

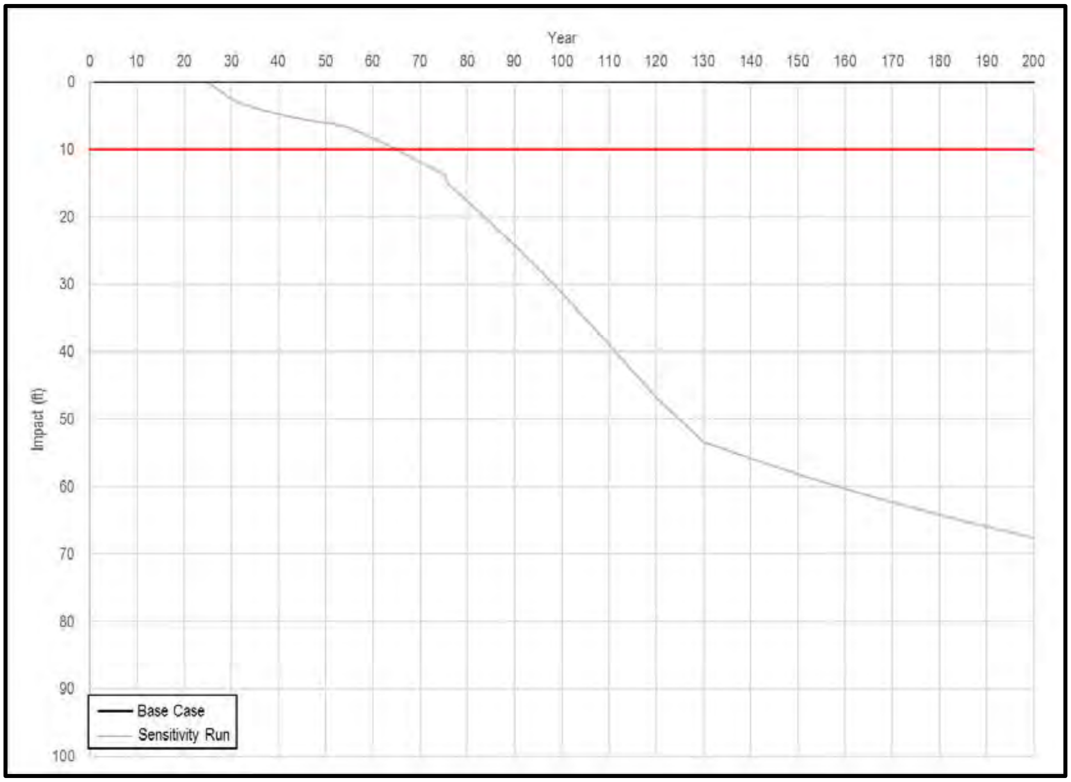

Figure L-17. Iberri Spring

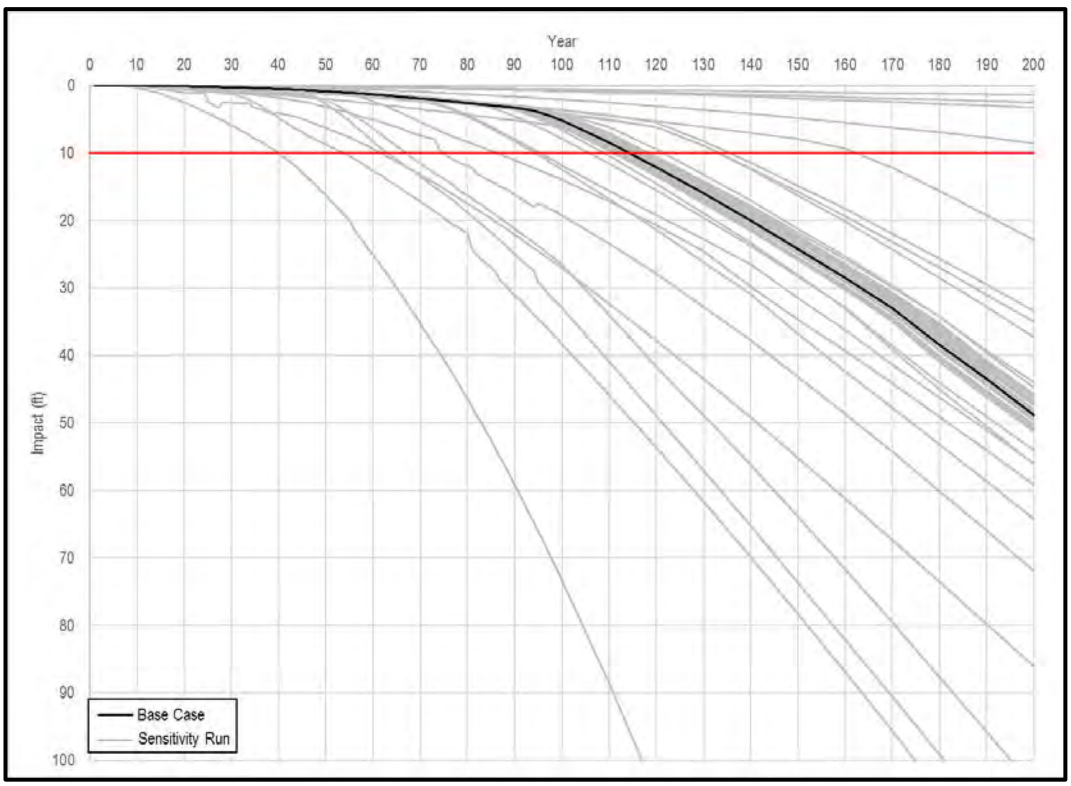

Figure L-18. Kane Spring

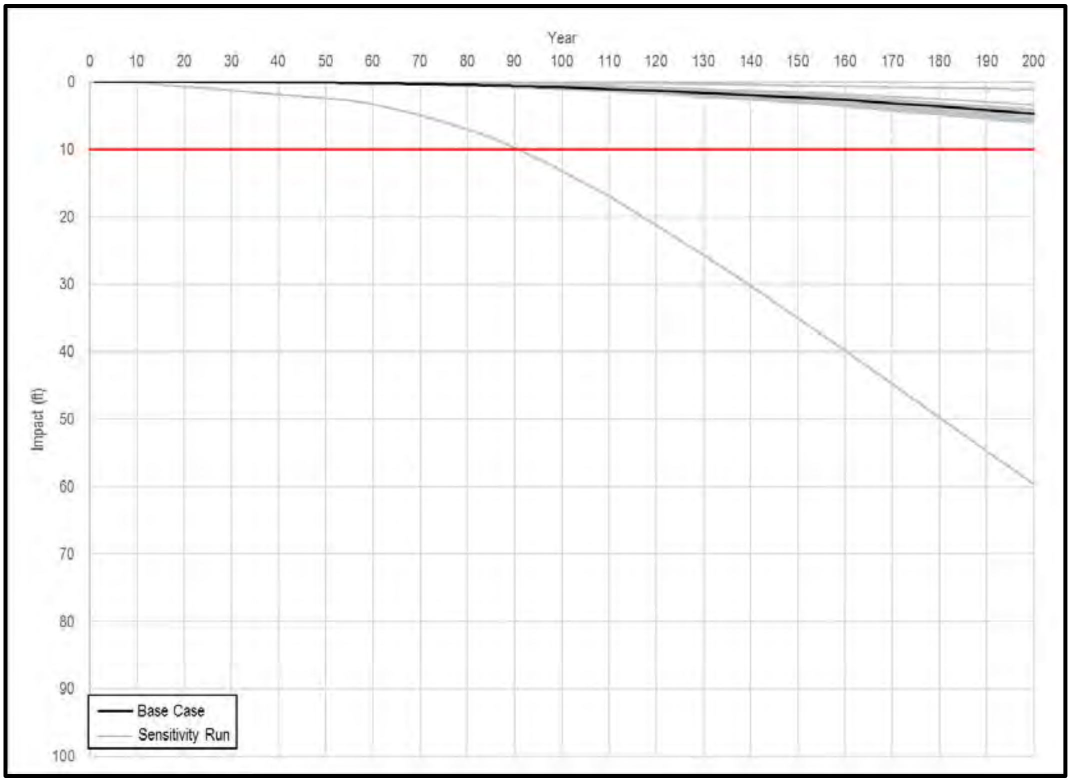

Figure L-19. McGinnel Mine Spring

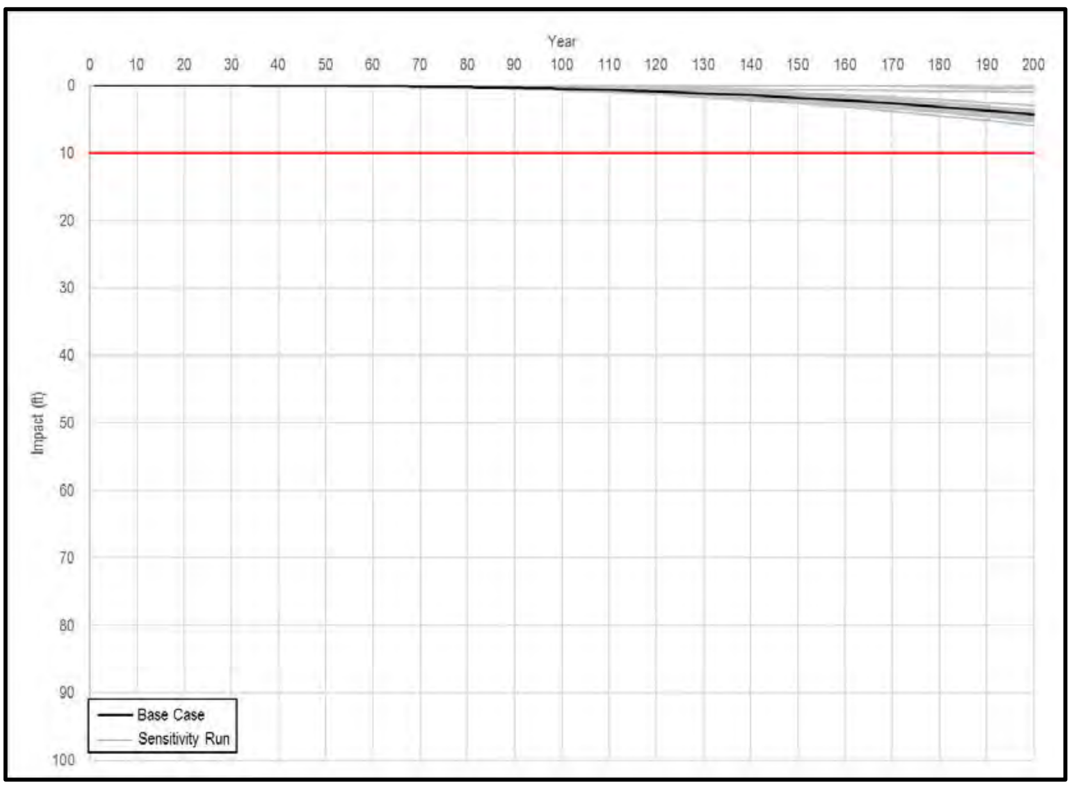

Figure L-20. McGinnel Spring

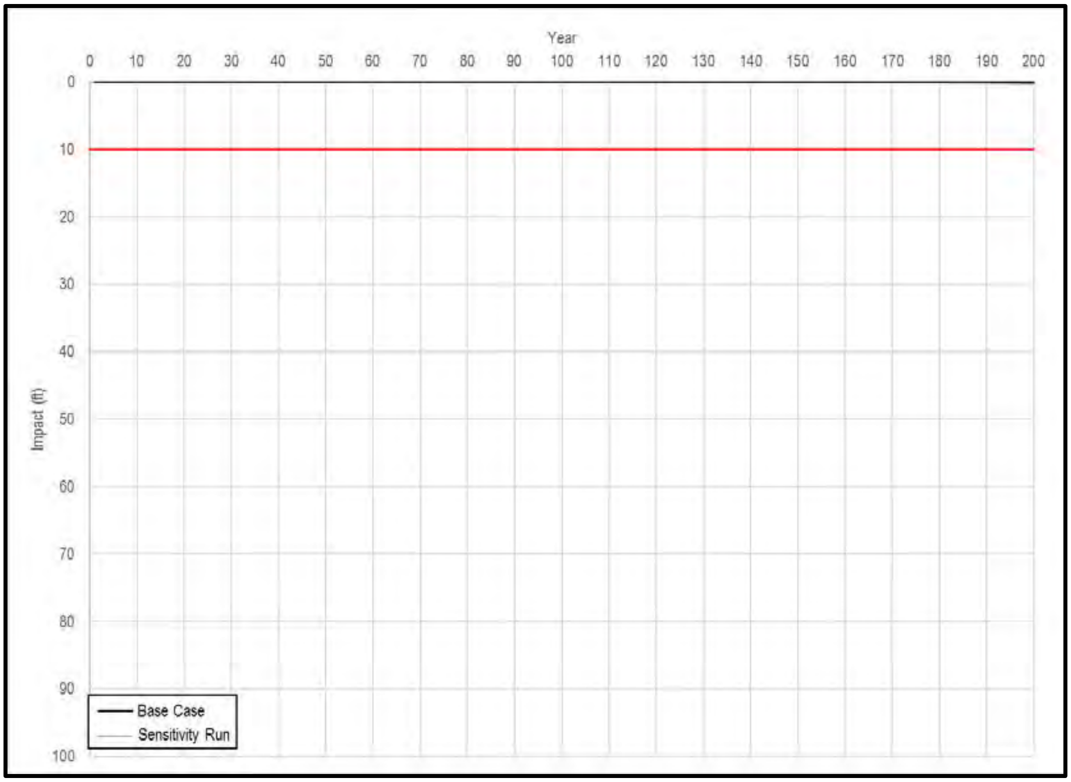

Figure L-21. No Name Spring

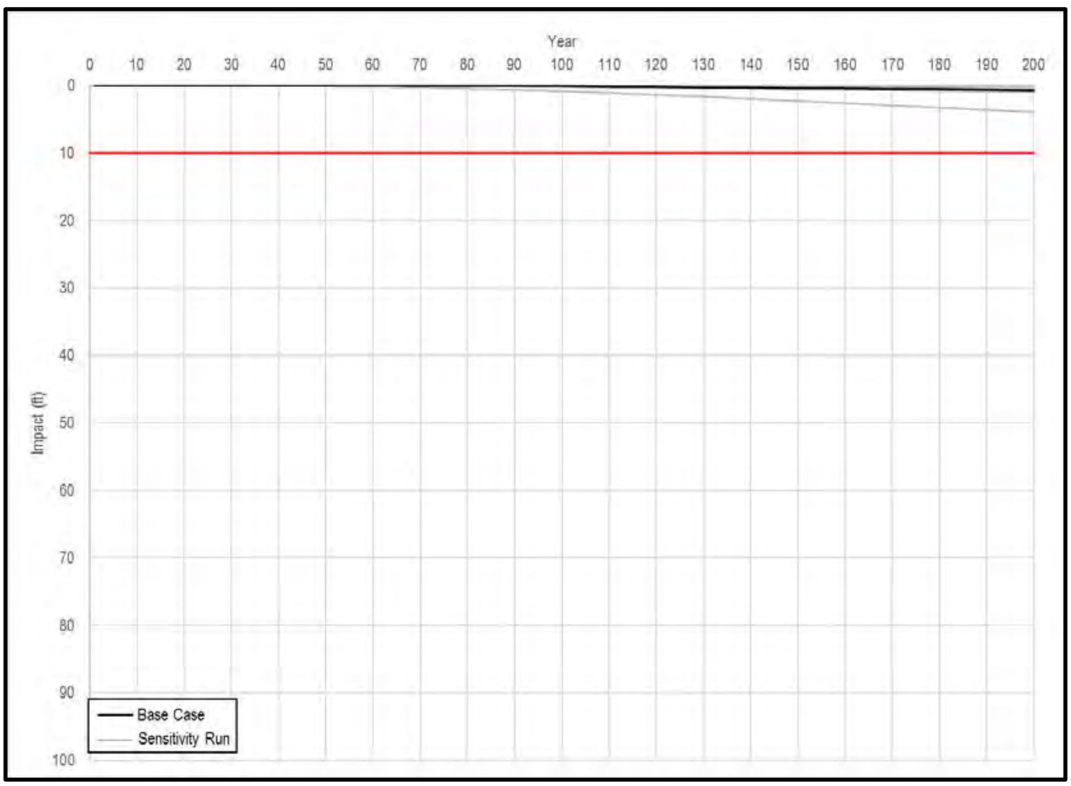

Figure L-22. Rock Horizontal Spring

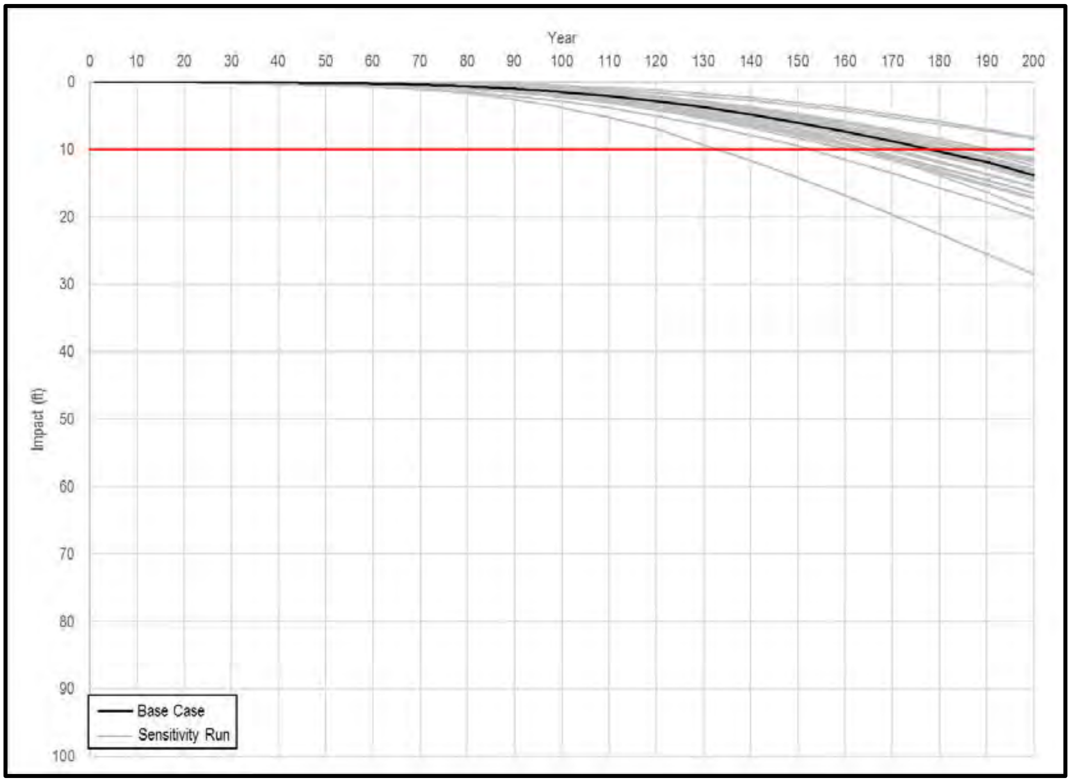

Figure L-23. Walker Spring

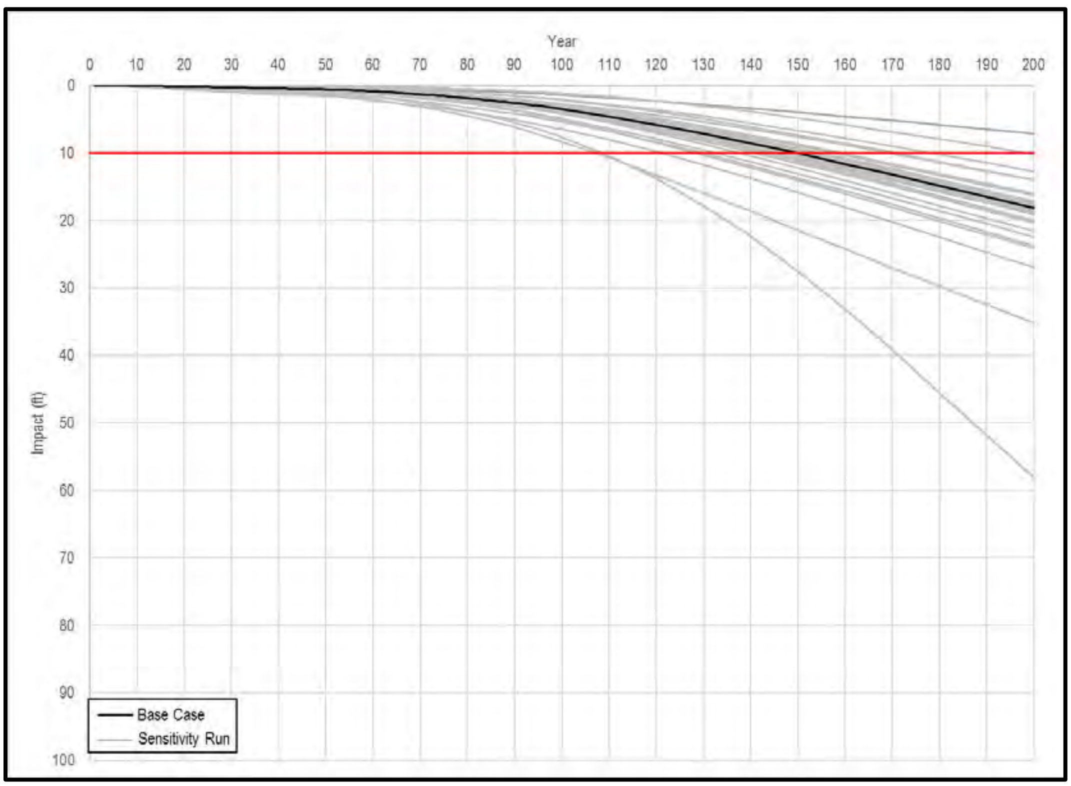

Figure L-24. DHRES-16_743 (Town of Superior)

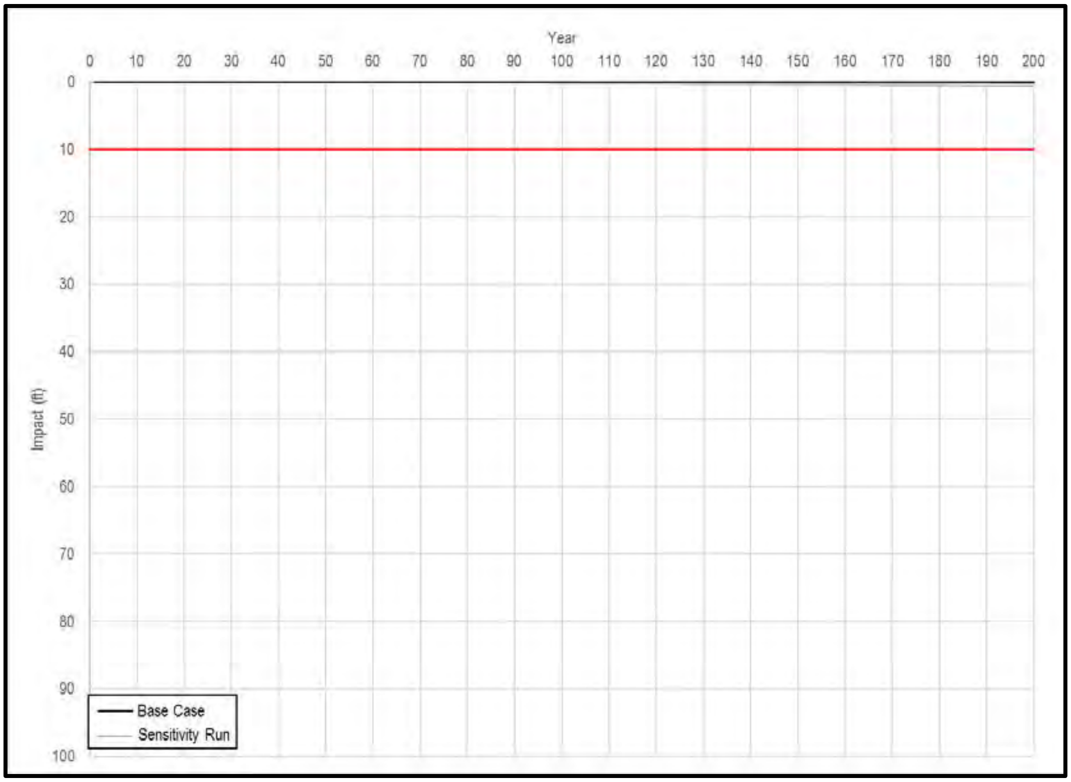

Figure L-25. Gallery Well (Boyce Thompson Arboretum)

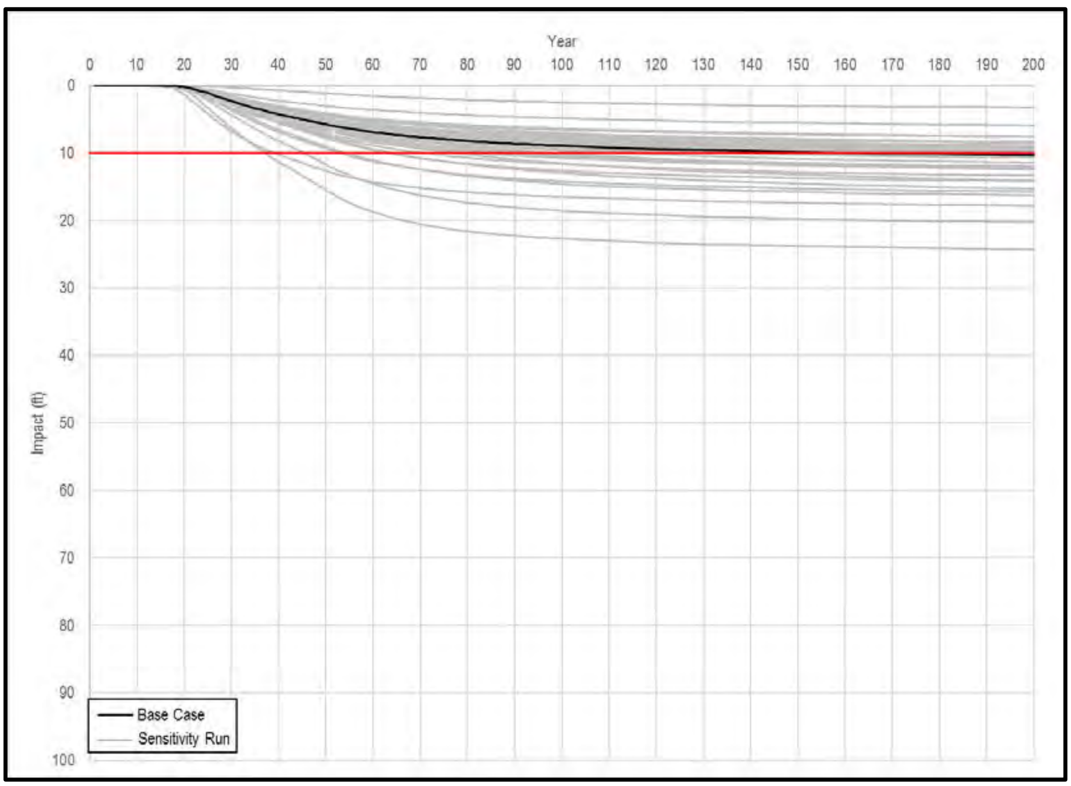

Figure L-26. HRES-06 (Top-of-the-World)

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APPENDIX M. WATER QUALITY MODELING RESULTS FOR CONSTITUENTS OF CONCERN

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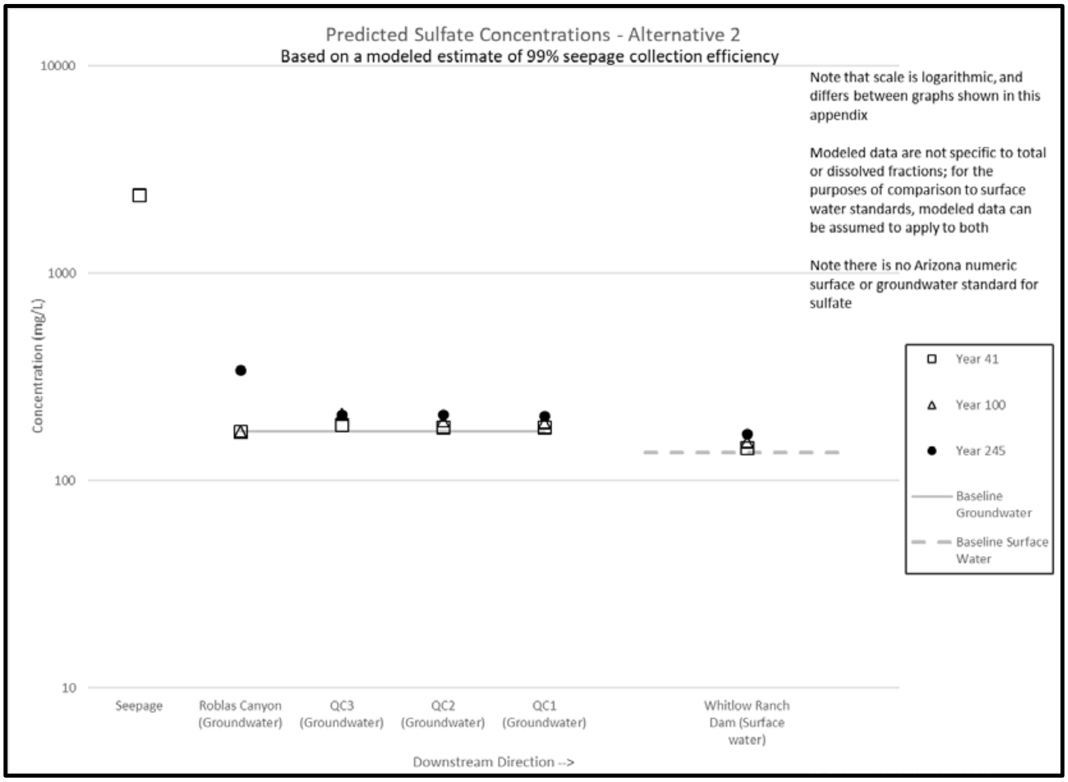

Figure M-1. Predicted sulfate concentrations, Alternative 2

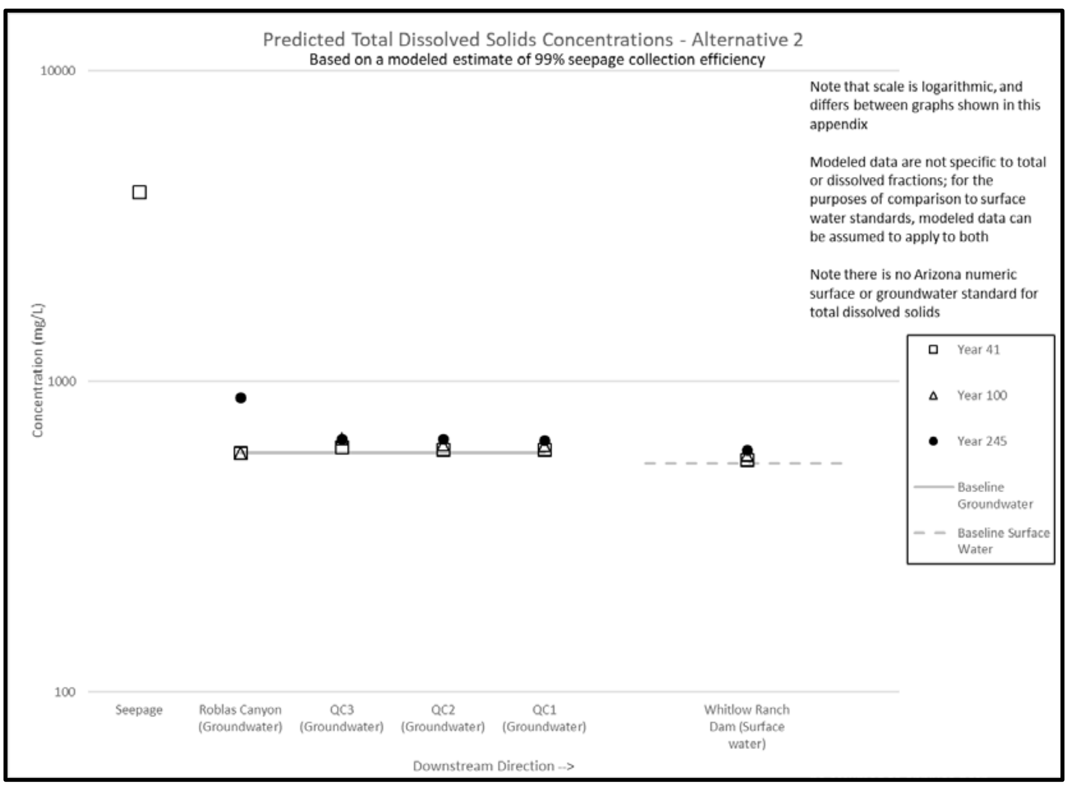

Figure M-2. Predicted total dissolved solids concentrations, Alternative 2

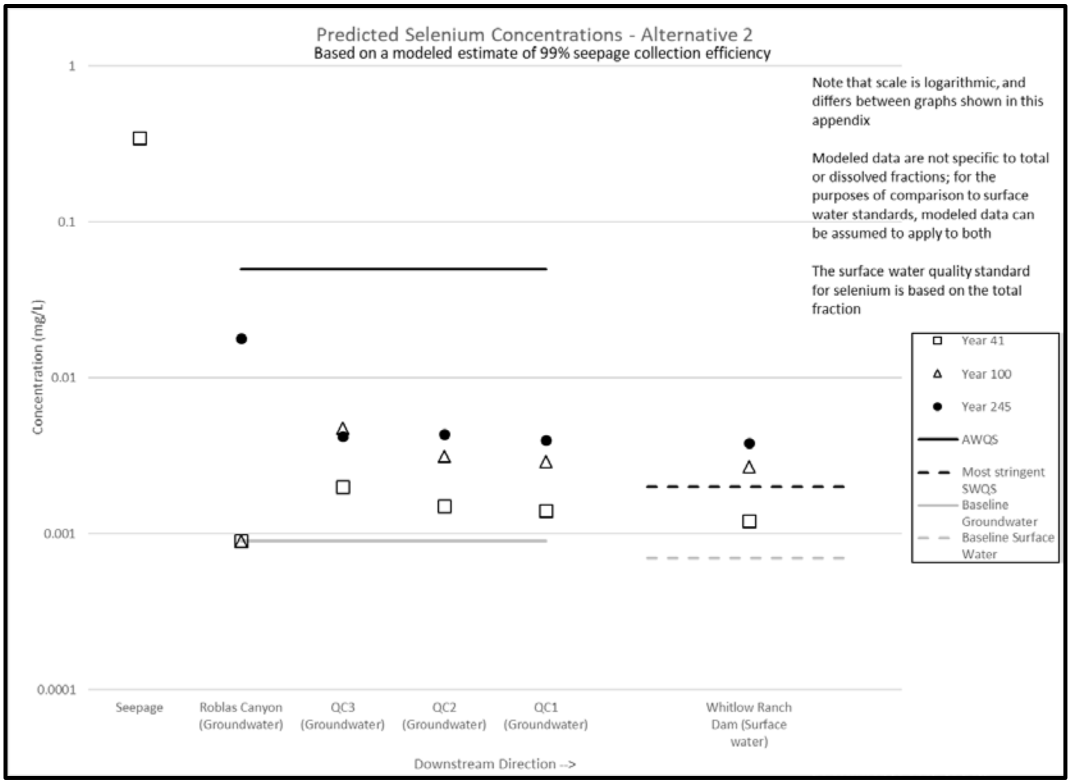

Figure M-3. Predicted selenium concentrations, Alternative 2

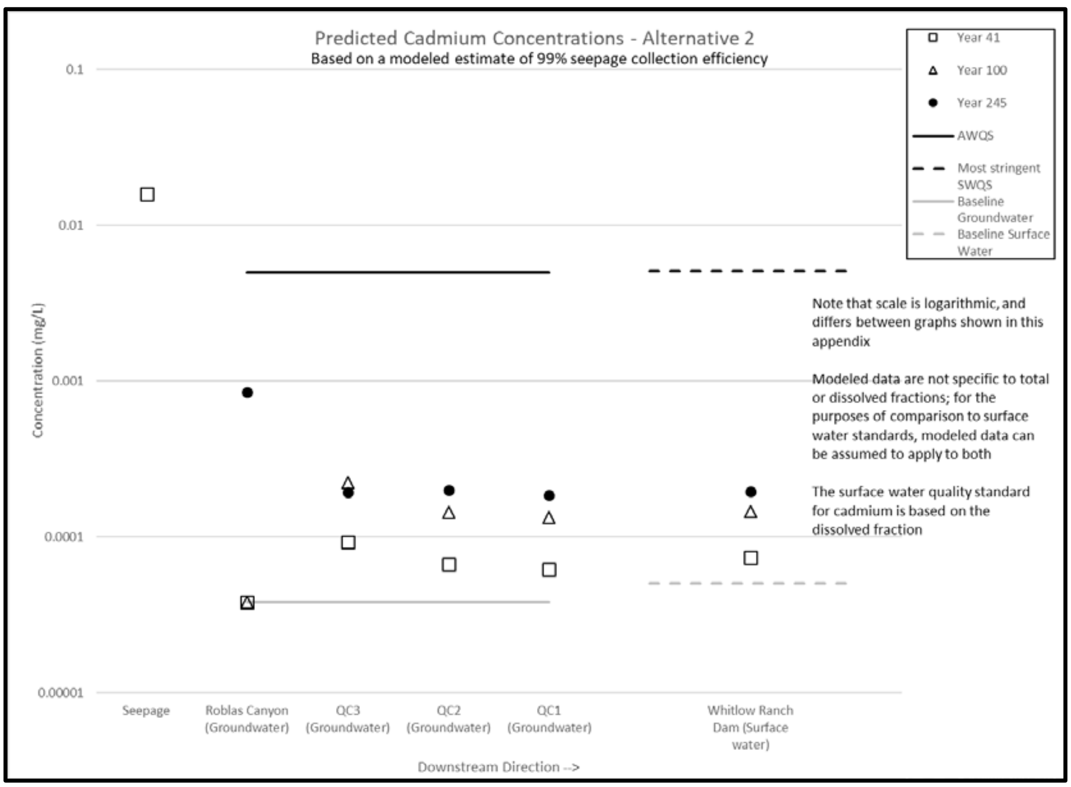

Figure M-4. Predicted cadmium concentrations, Alternative 2

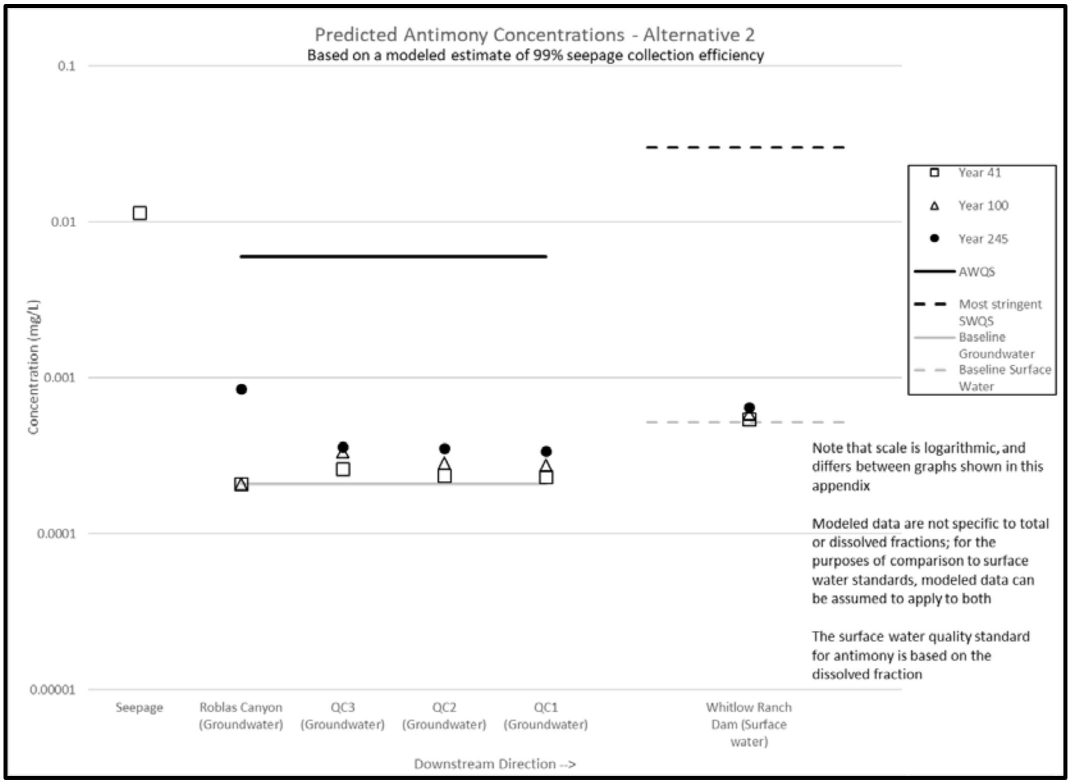

Figure M-5. Predicted antimony concentrations, Alternative 2

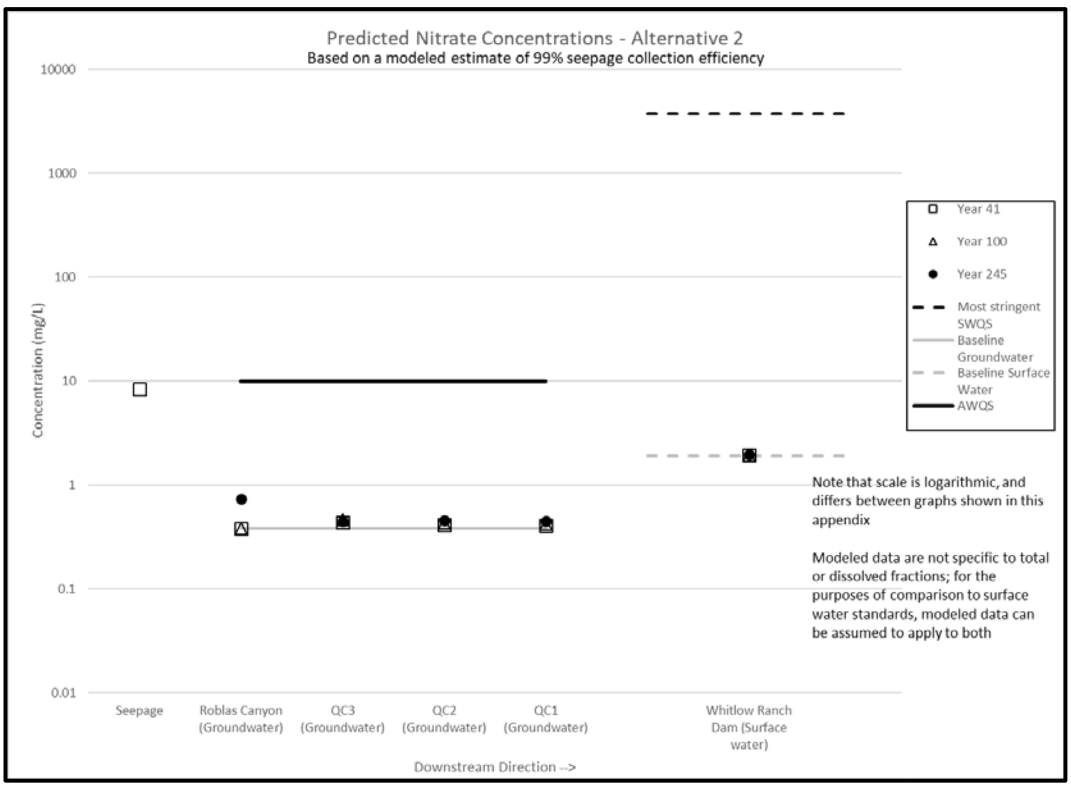

Figure M-6. Predicted nitrate concentrations, Alternative 2

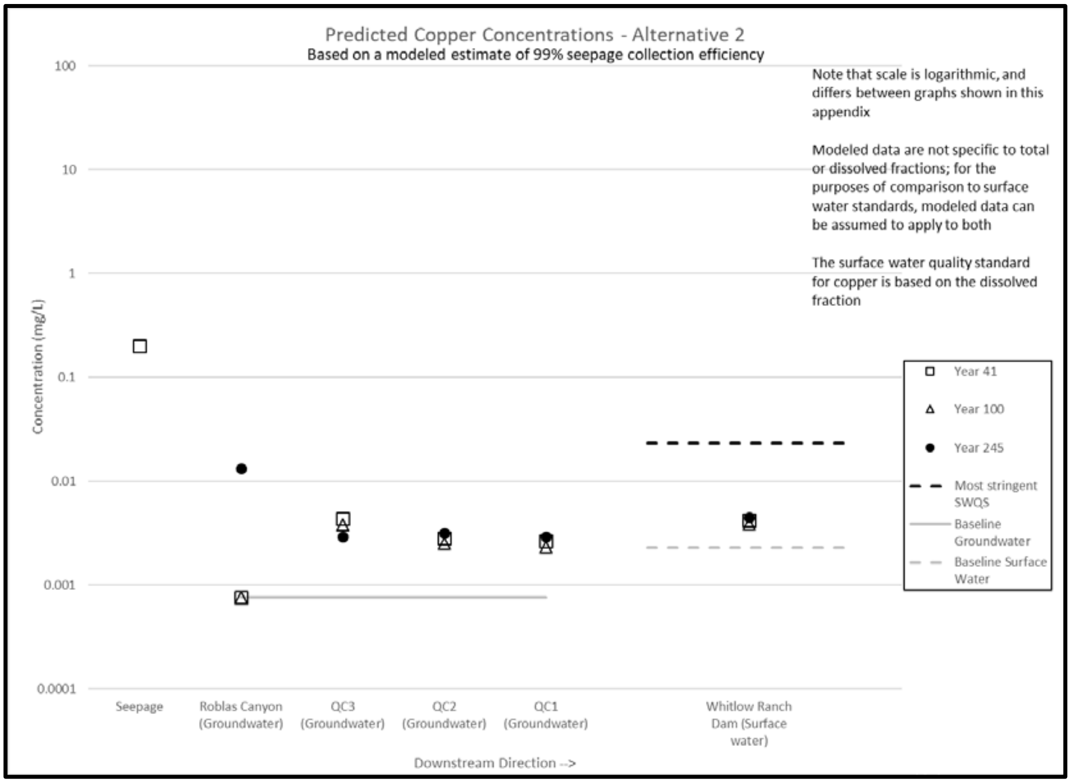

Figure M-7. Predicted copper concentrations, Alternative 2

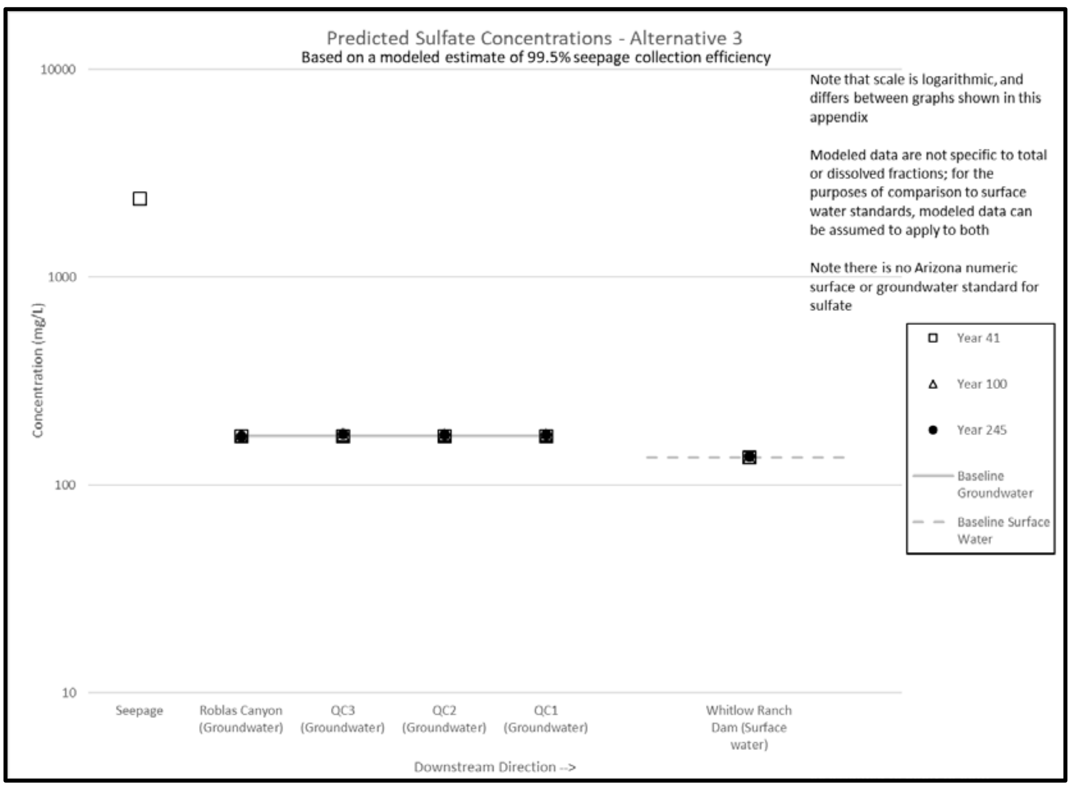

Figure M-8. Predicted sulfate concentrations, Alternative 3

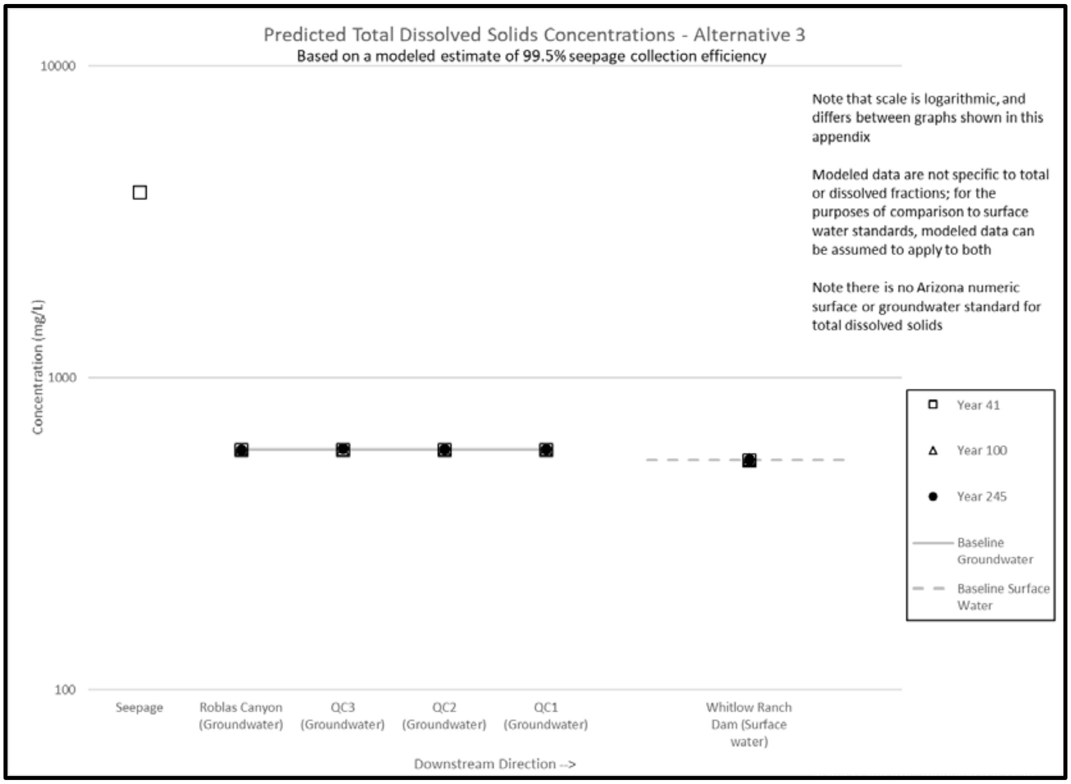

Figure M-9. Predicted total dissolved solids concentrations, Alternative 3

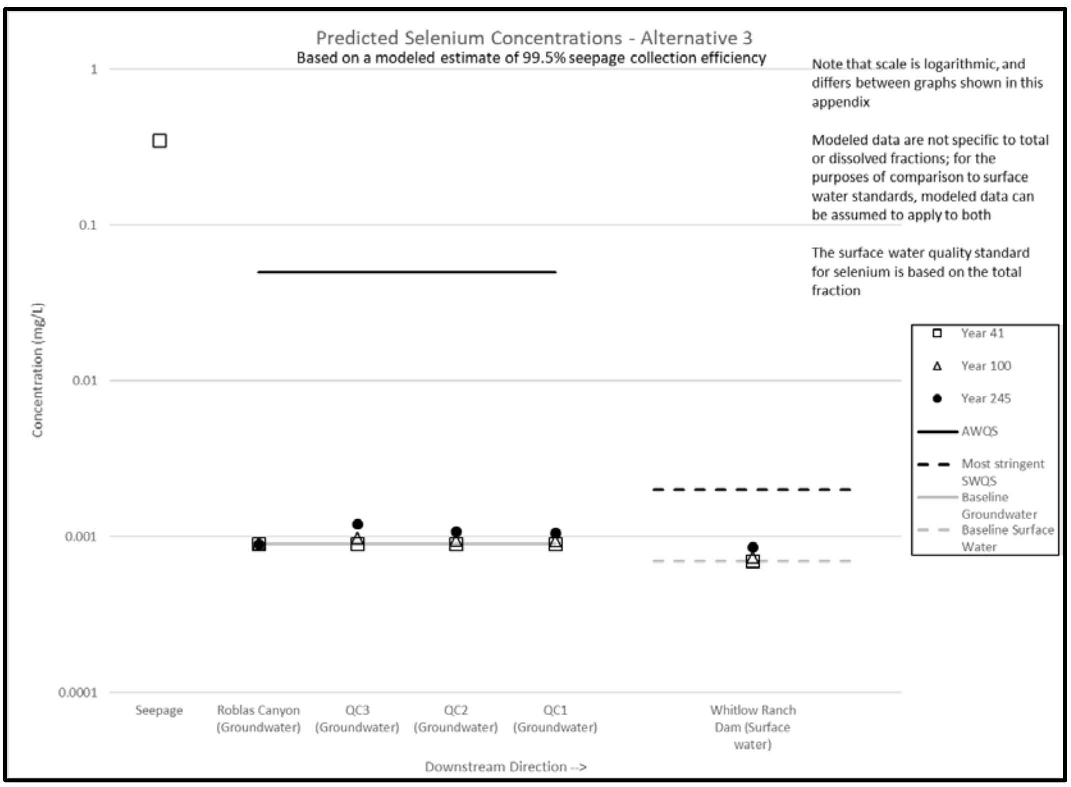

Figure M-10. Predicted selenium concentrations, Alternative 3

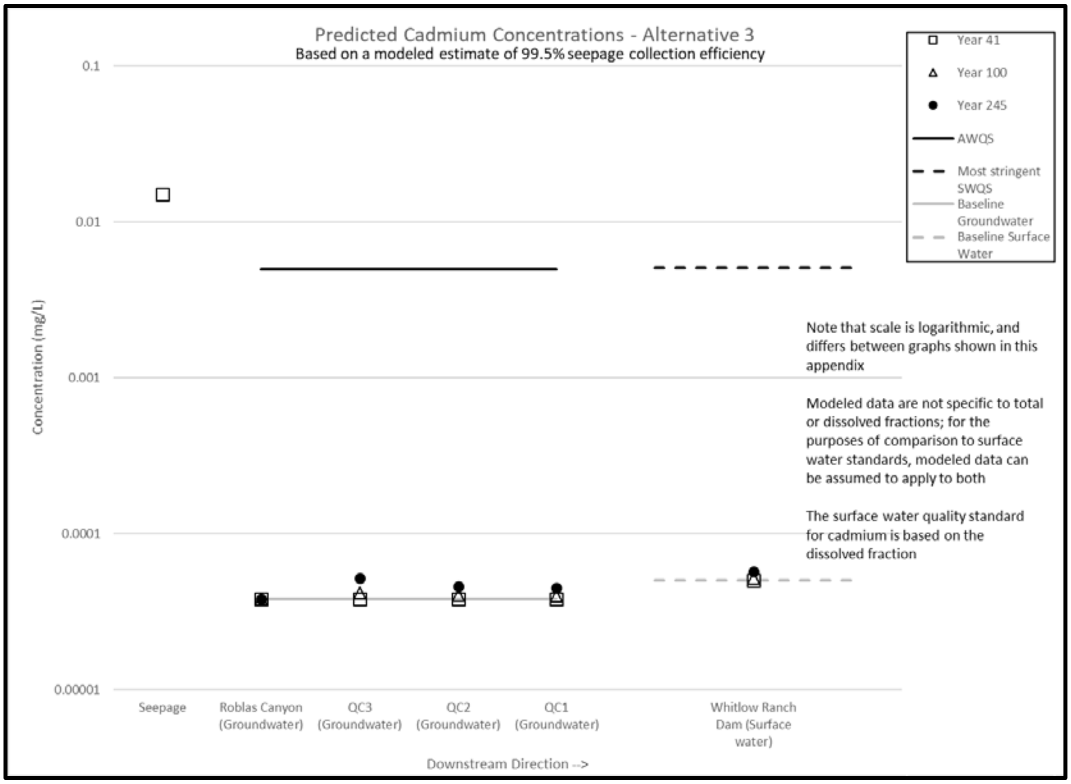

Figure M-11. Predicted cadmium concentrations, Alternative 3

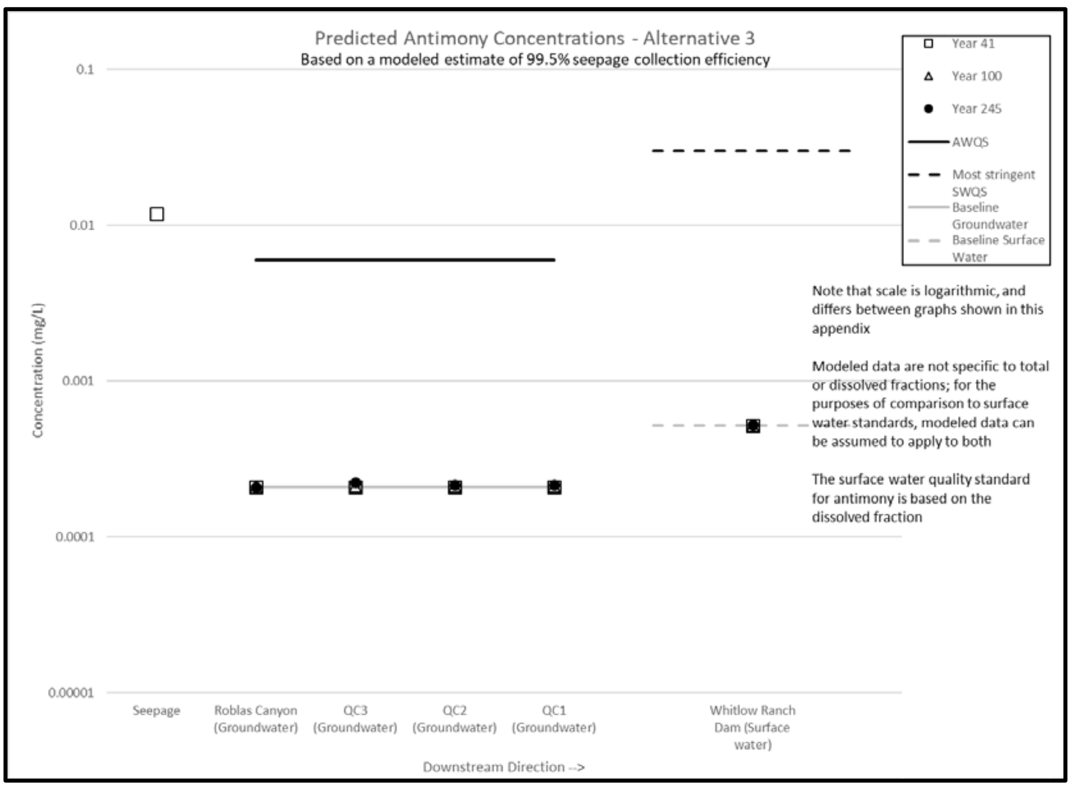

Figure M-12. Predicted antimony concentrations, Alternative 3

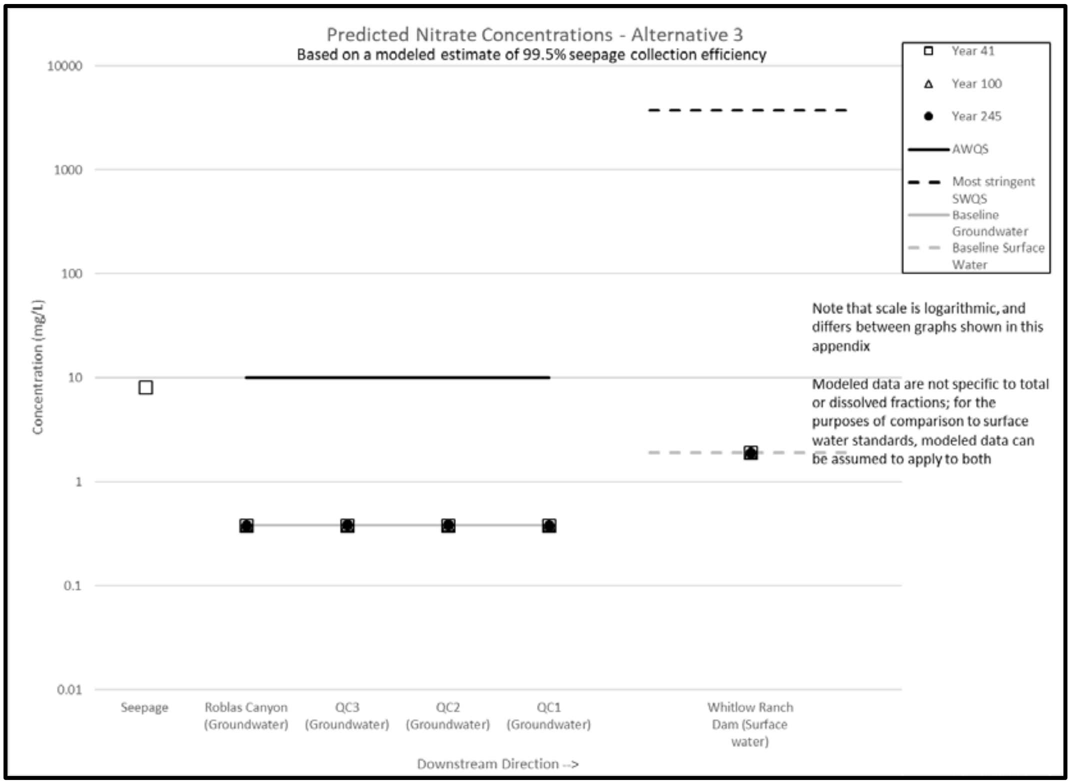

Figure M-13. Predicted nitrate concentrations, Alternative 3

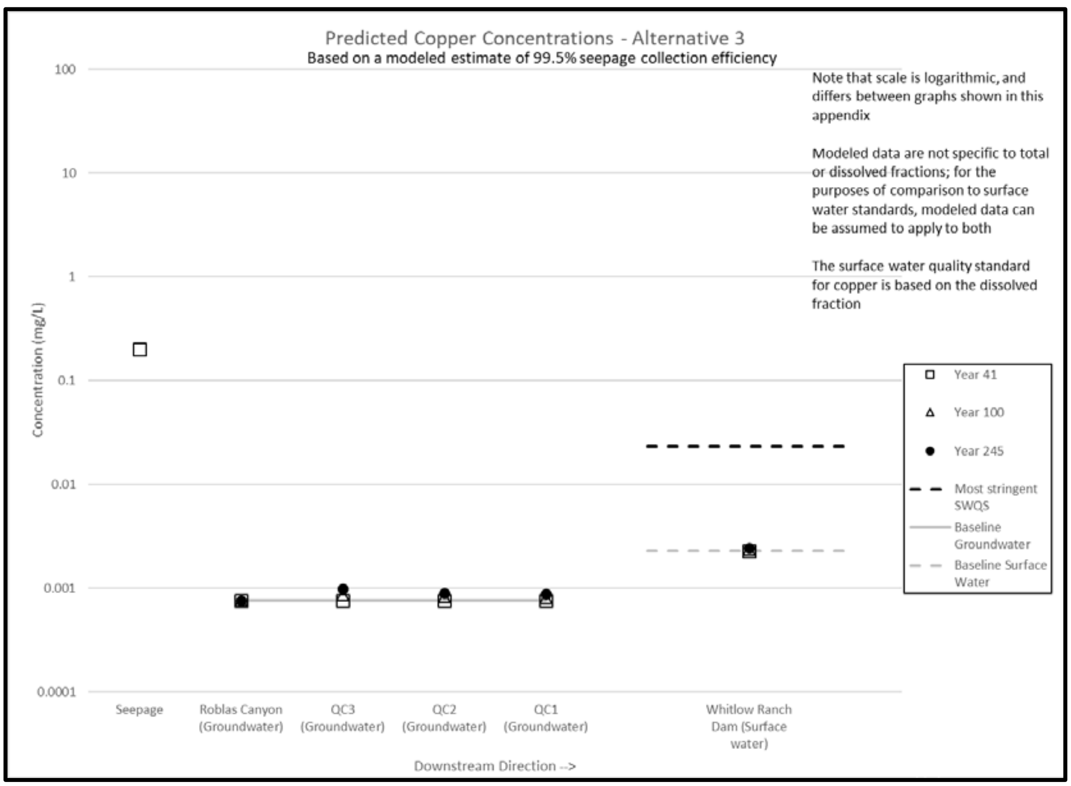

Figure M-14. Predicted copper concentrations, Alternative 3

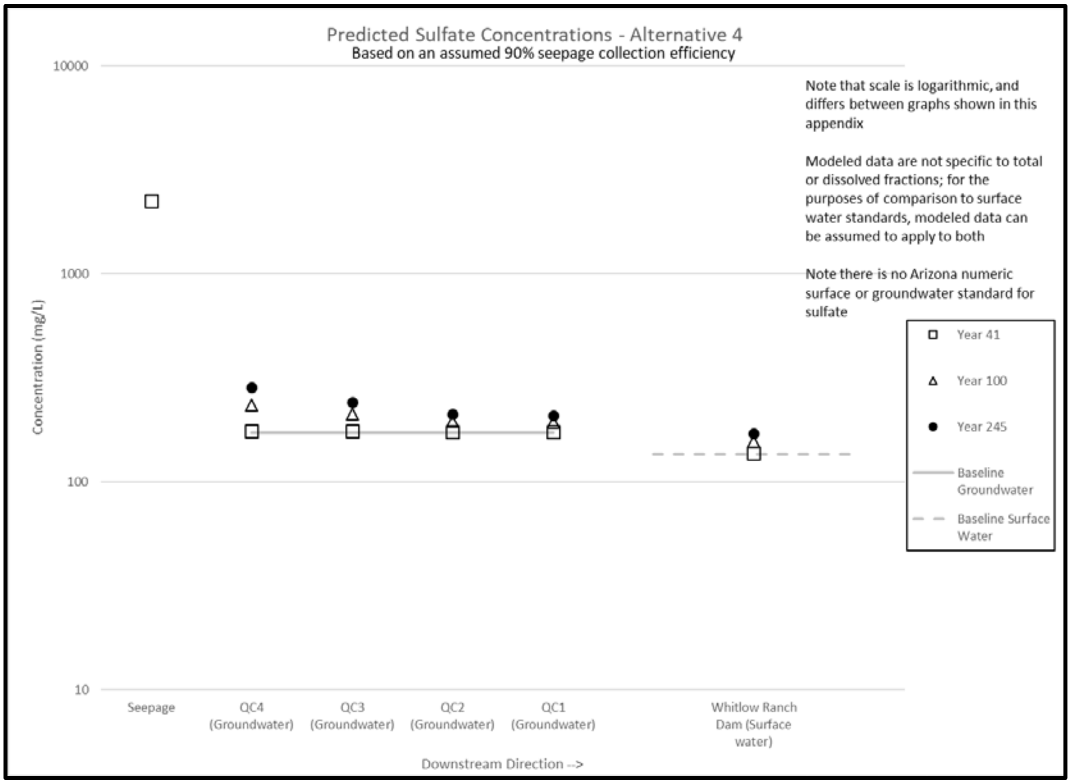

Figure M-15. Predicted sulfate concentrations, Alternative 4

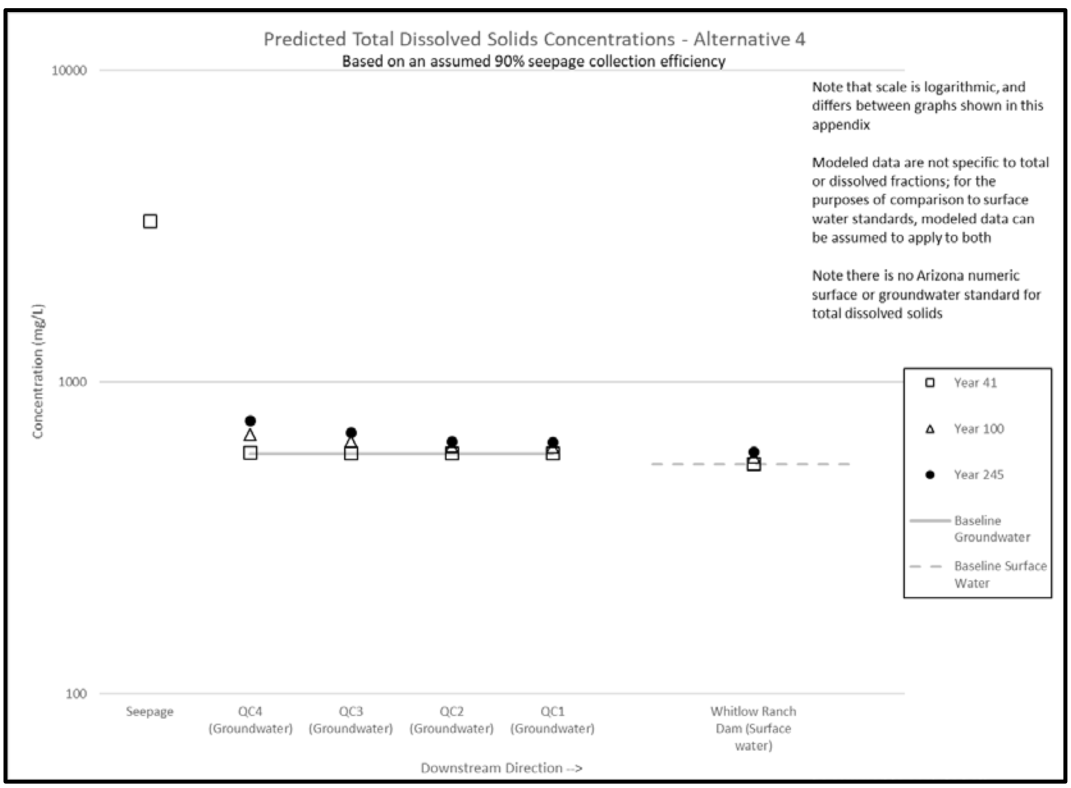

Figure M-16. Predicted total dissolved solids concentrations, Alternative 4

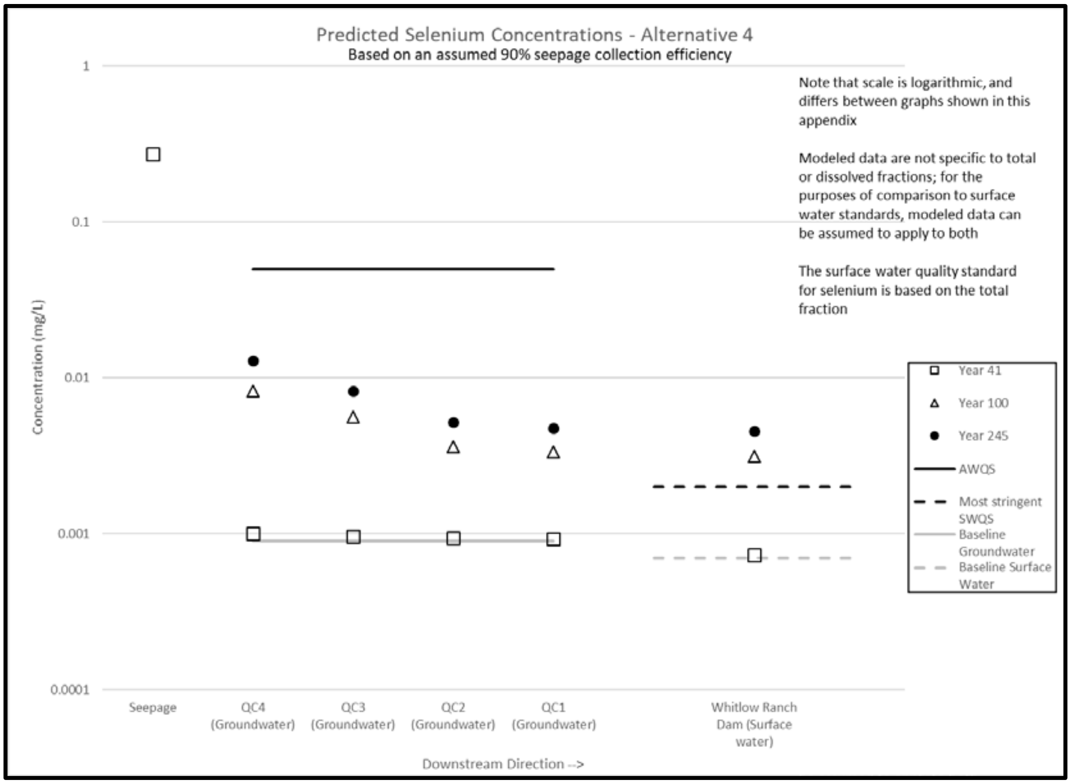

Figure M-17. Predicted selenium concentrations, Alternative 4

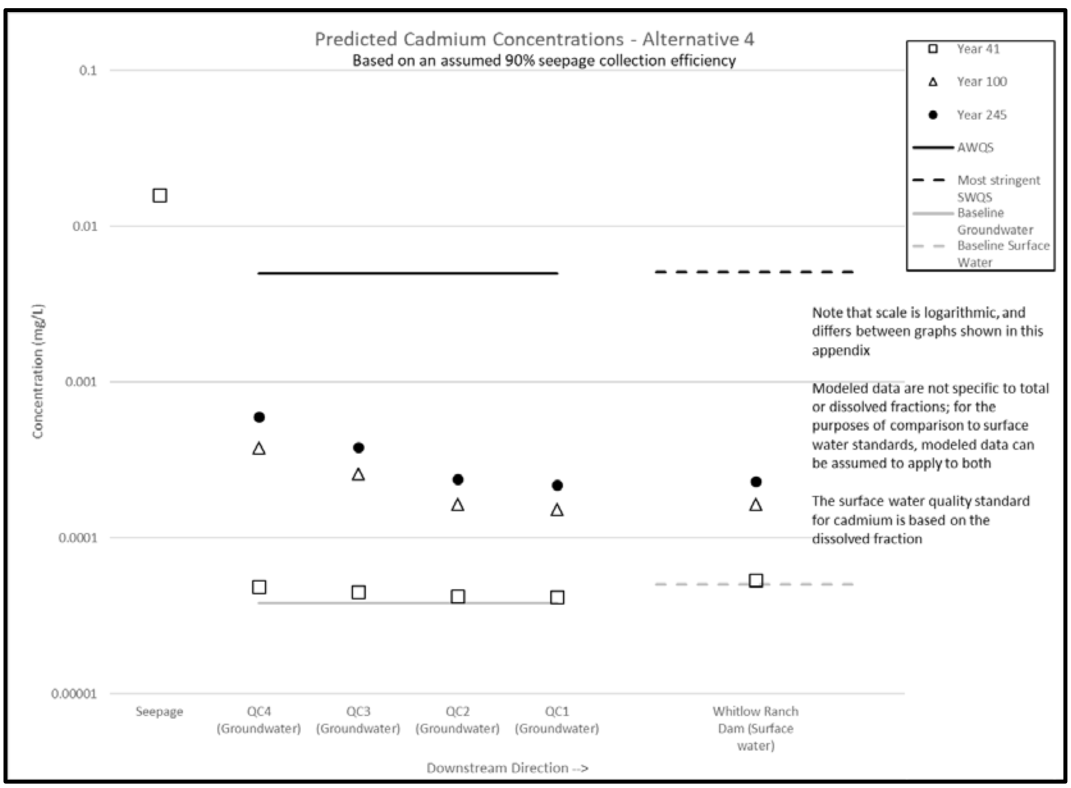

Figure M-18. Predicted cadmium concentrations, Alternative 4

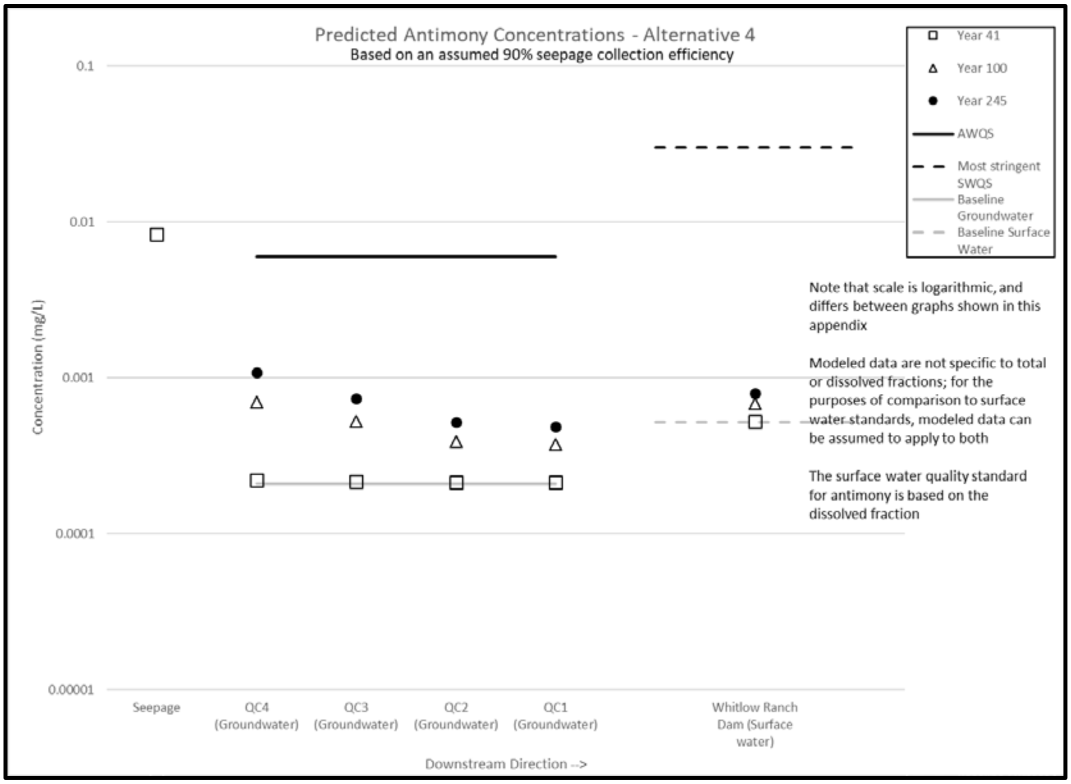

Figure M-19. Predicted antimony concentrations, Alternative 4

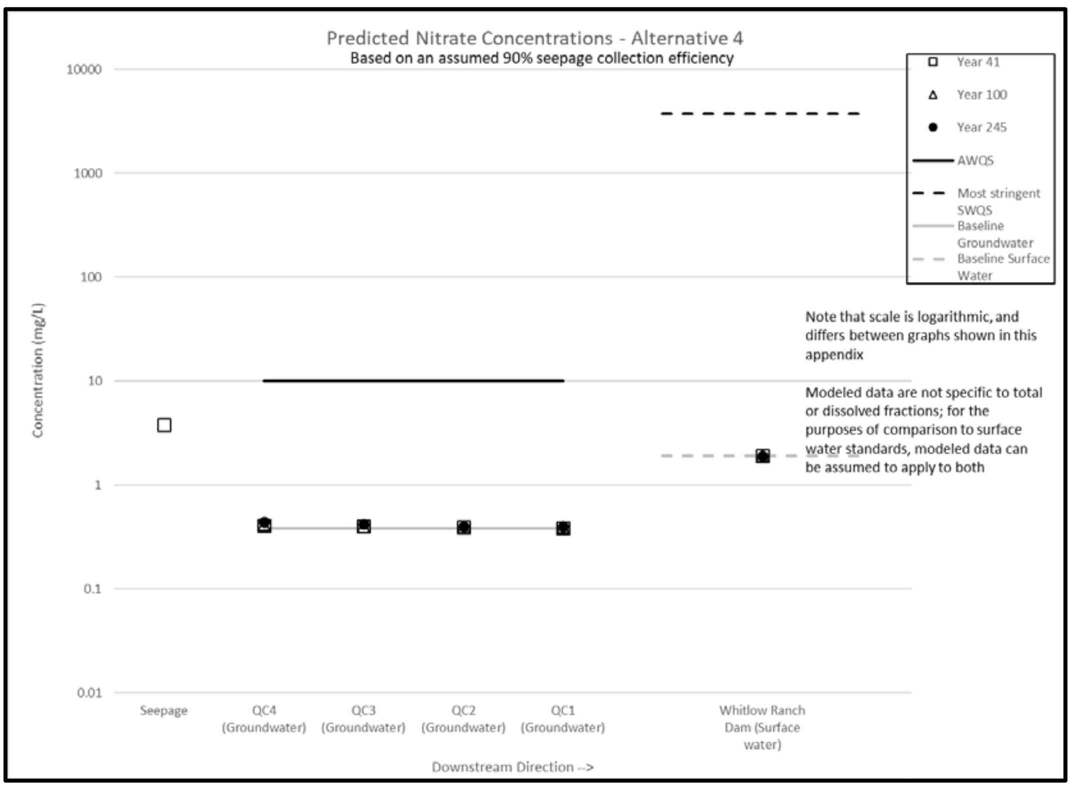

Figure M-20. Predicted nitrate concentrations, Alternative 4

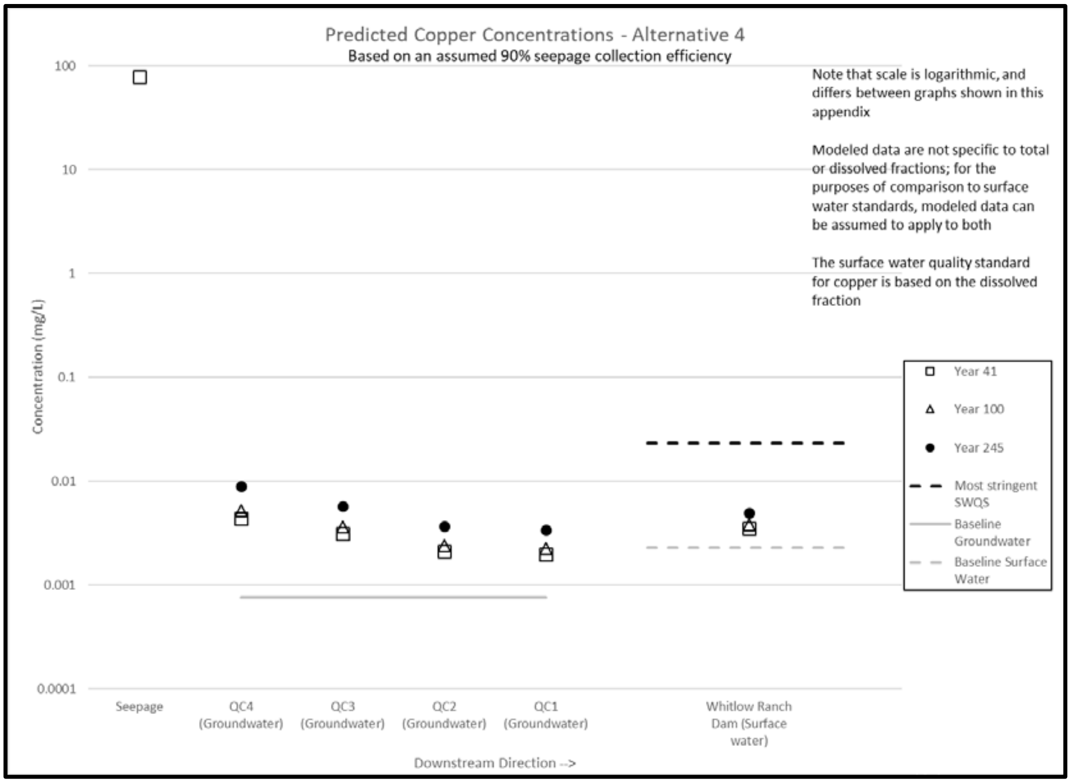

Figure M-21. Predicted copper concentrations, Alternative 4

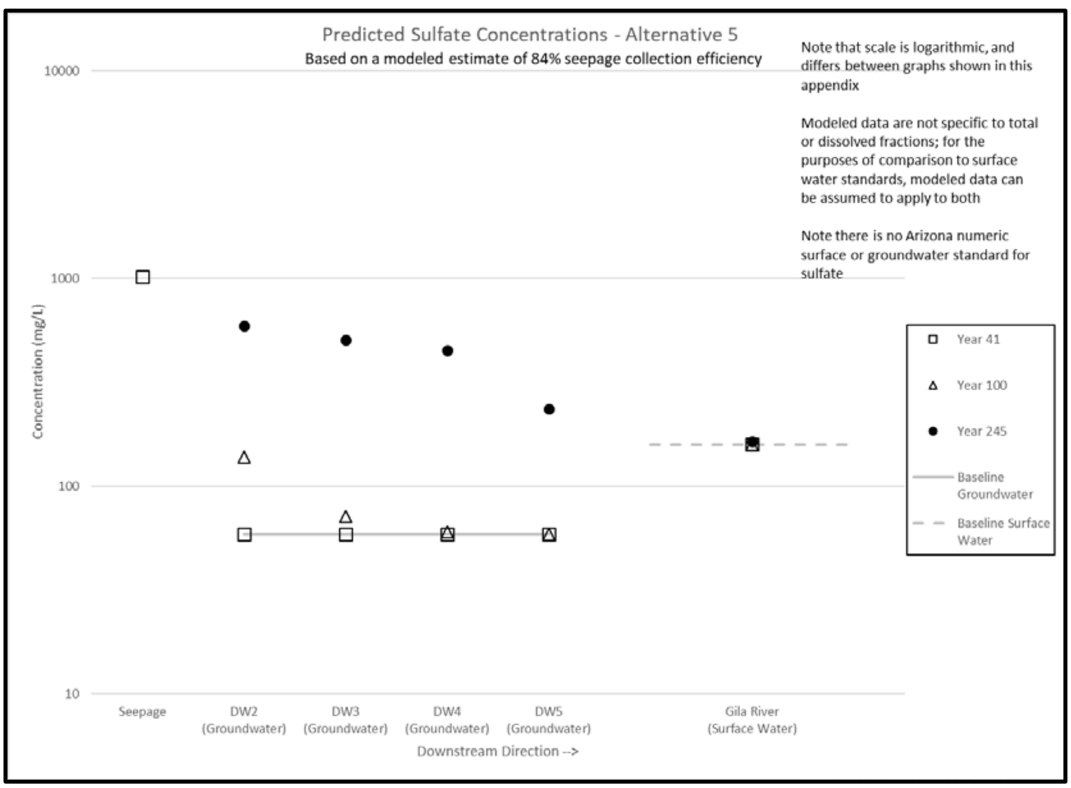

Figure M-22. Predicted sulfate concentrations, Alternative 5

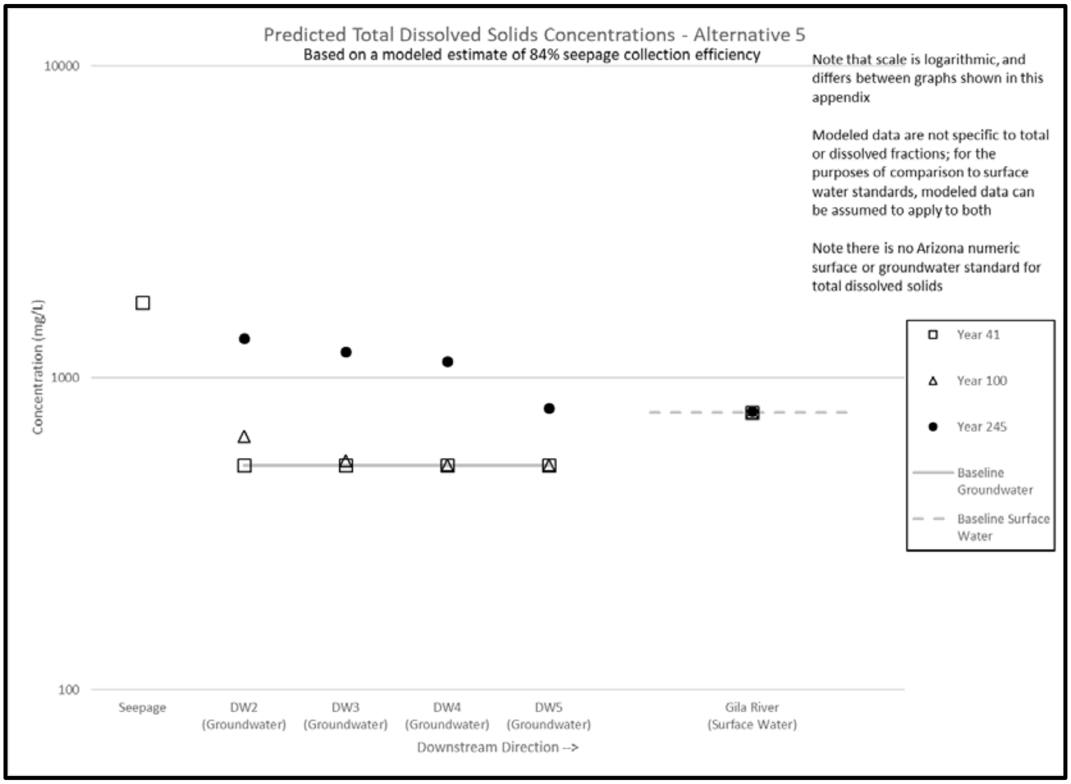

Figure M-23. Predicted total dissolved solids concentrations, Alternative 5

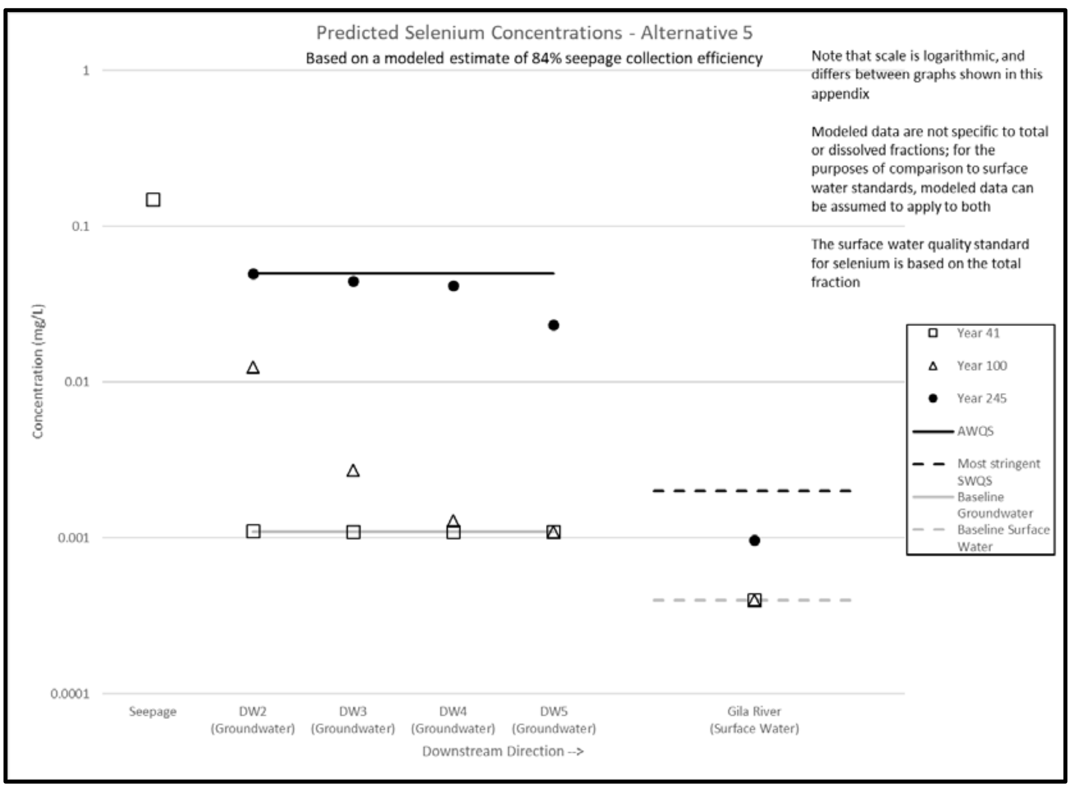

Figure M-24. Predicted selenium concentrations, Alternative 5

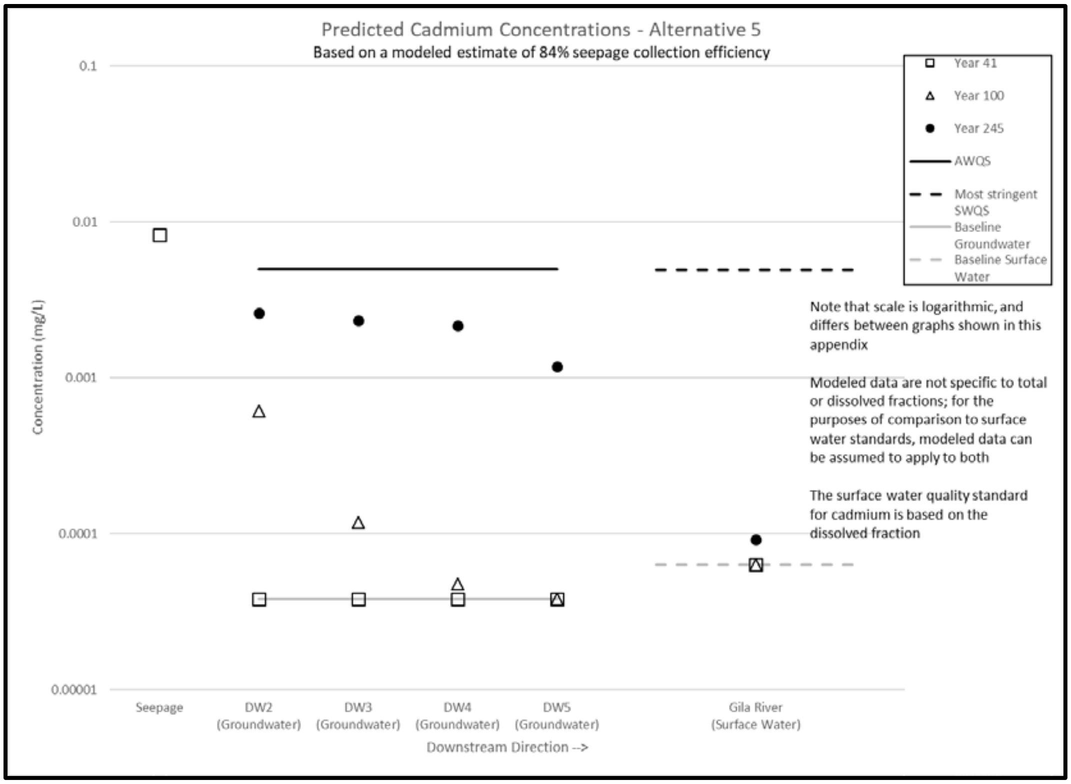

Figure M-25. Predicted cadmium concentrations, Alternative 5

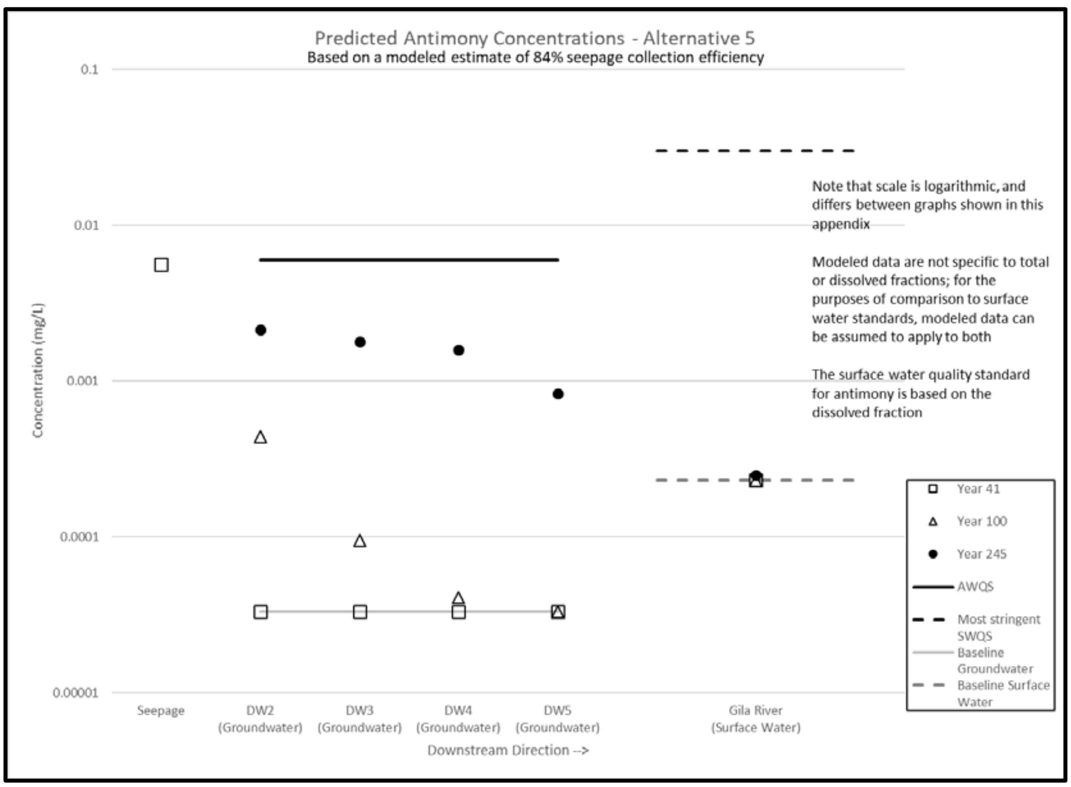

Figure M-26. Predicted antimony concentrations, Alternative 5

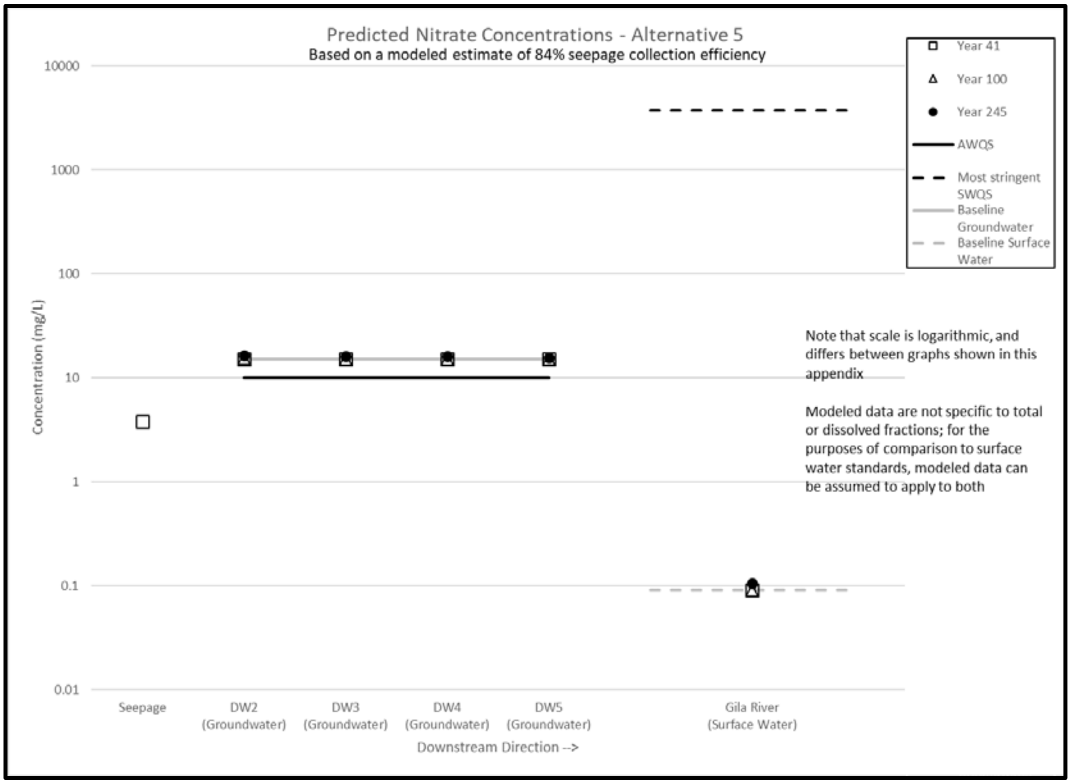

Figure M-27. Predicted nitrate concentrations, Alternative 5

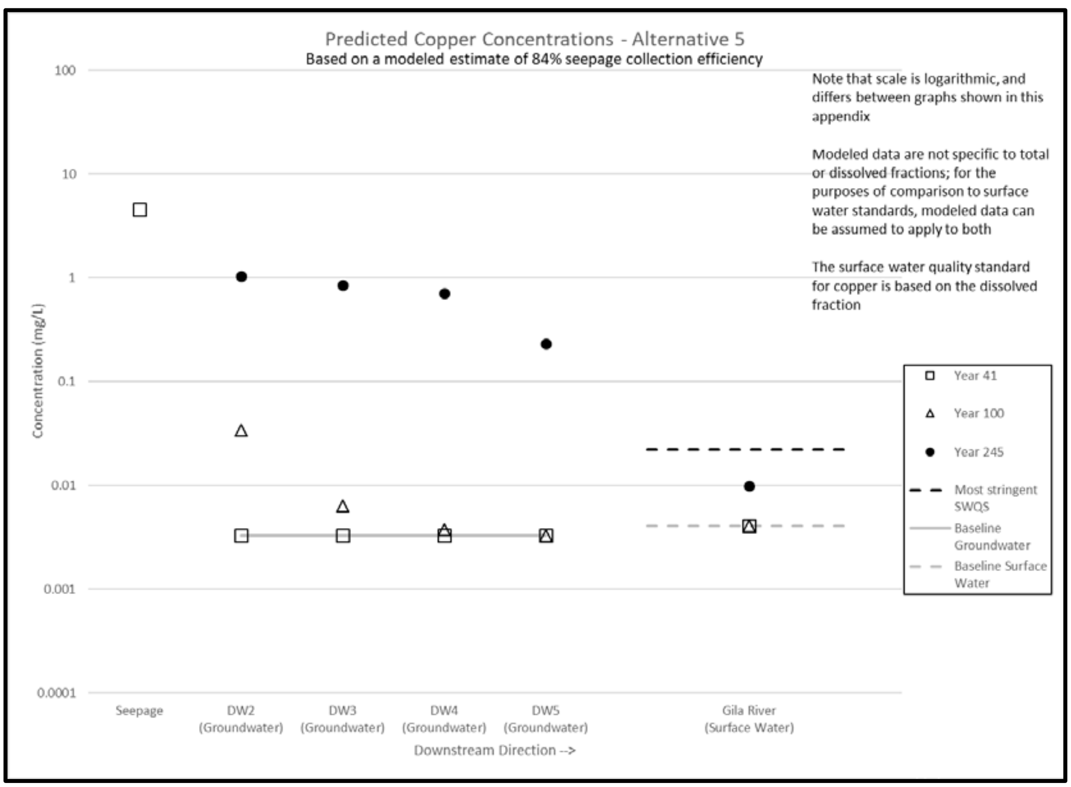

Figure M-28. Predicted copper concentrations, Alternative 5

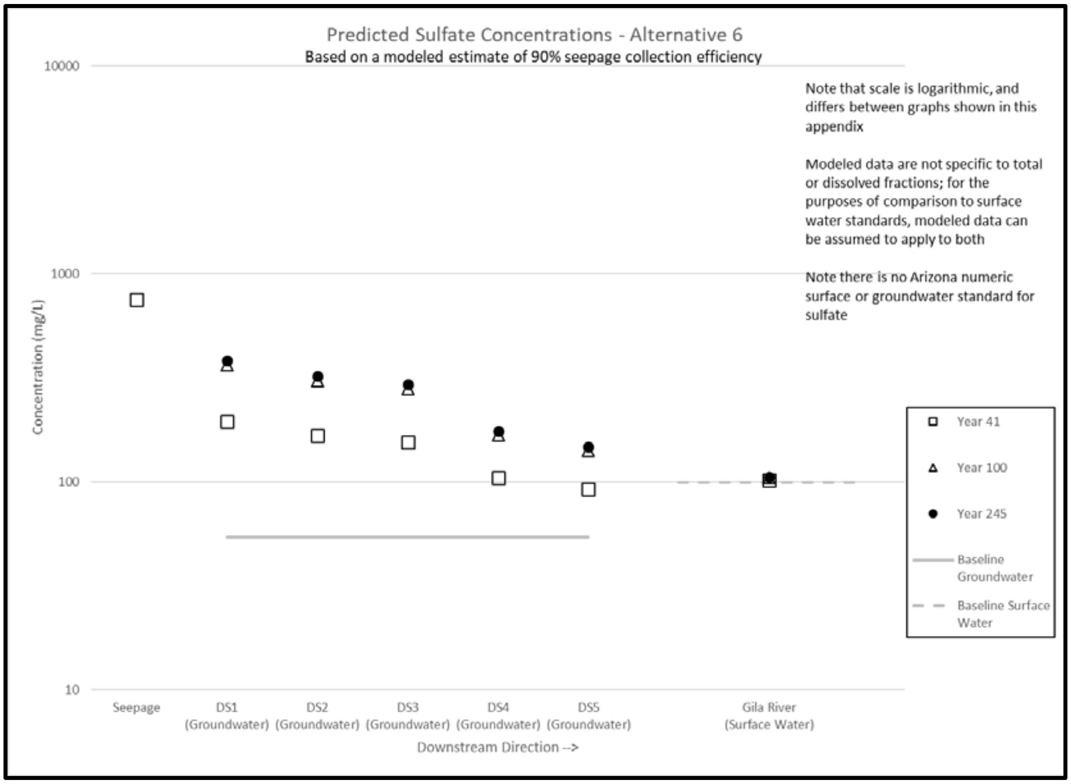

Figure M-29. Predicted sulfate concentrations, Alternative 6

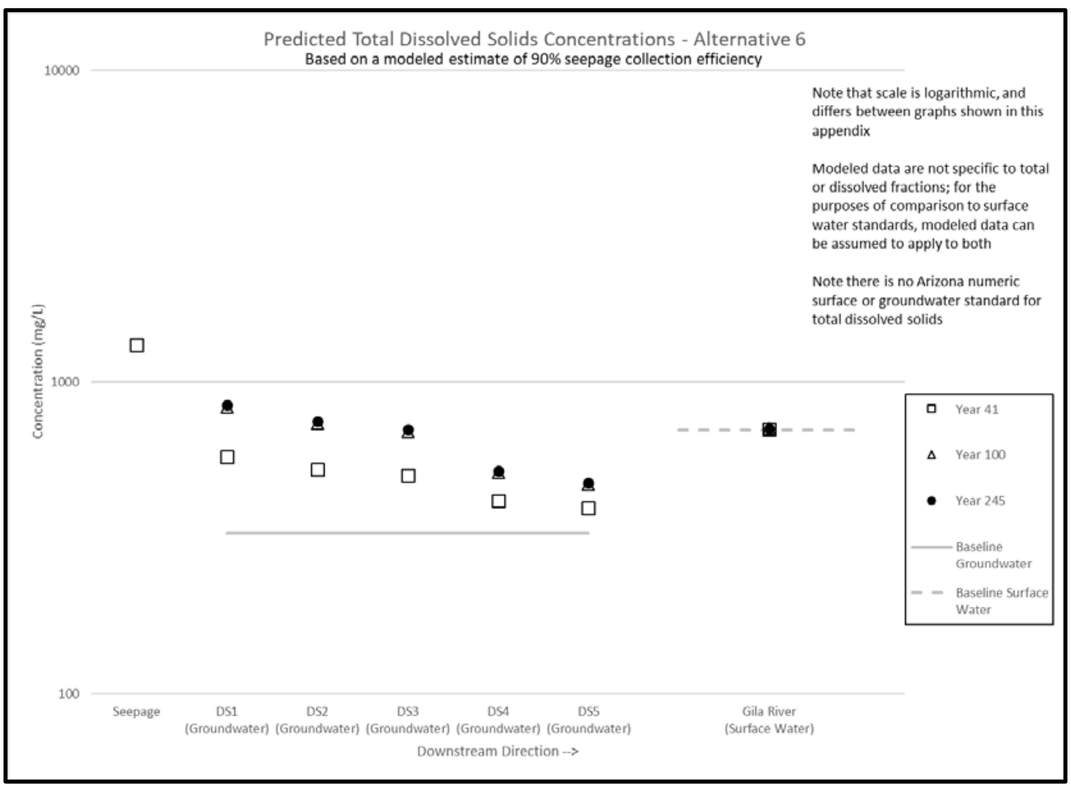

Figure M-30. Predicted total dissolved solids concentrations, Alternative 6

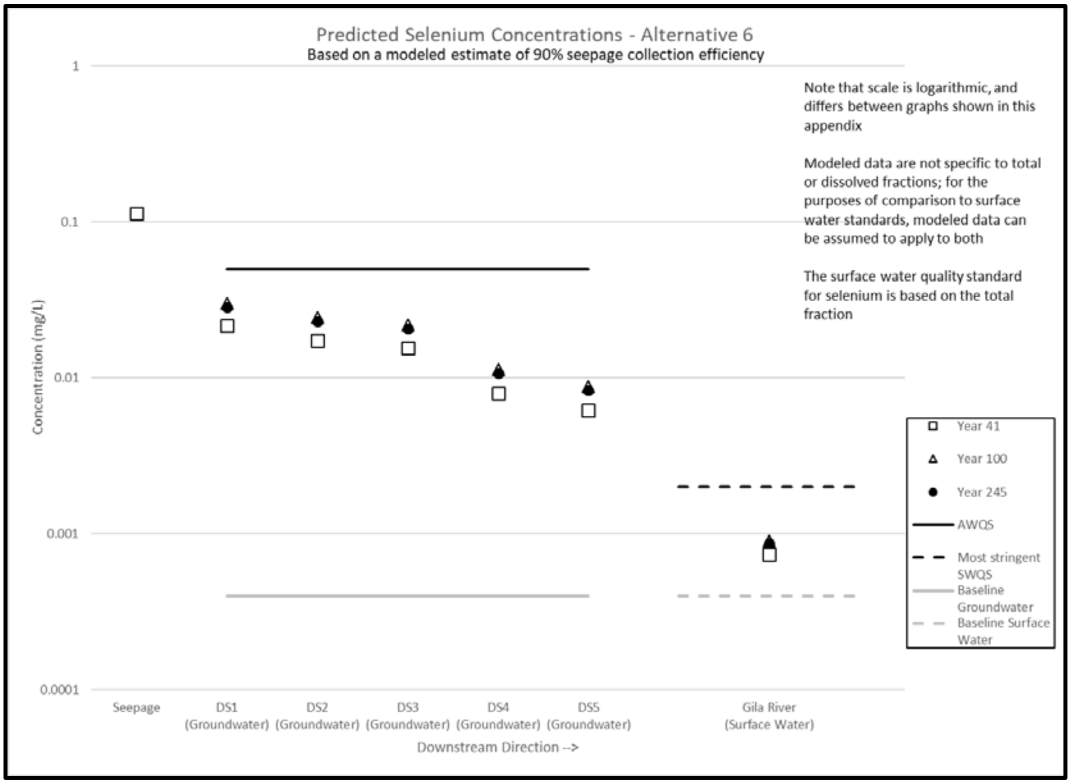

Figure M-31. Predicted selenium concentrations, Alternative 6

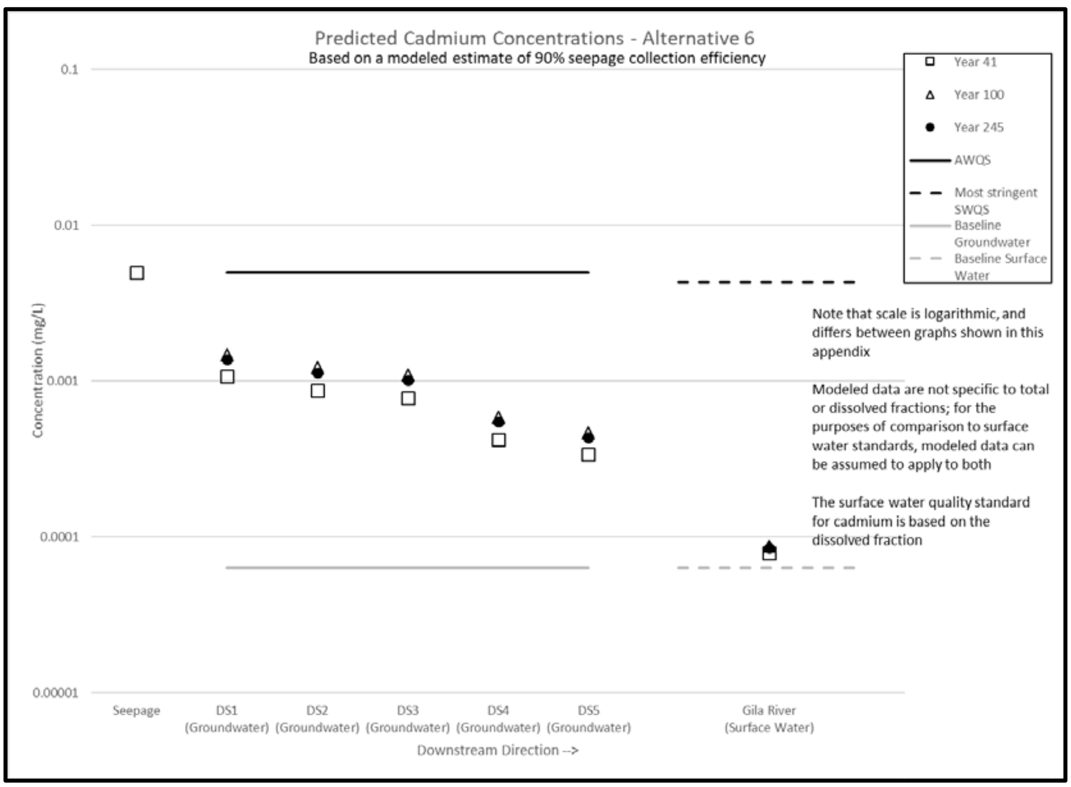

Figure M-32. Predicted cadmium concentrations, Alternative 6

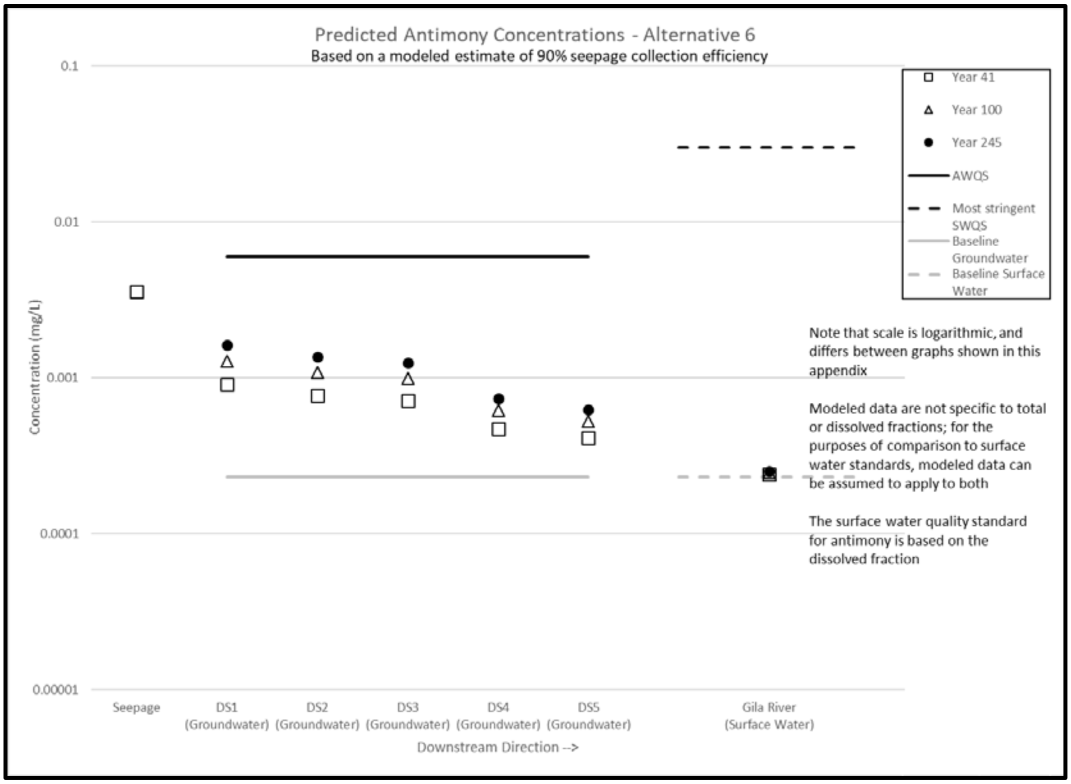

Figure M-33. Predicted antimony concentrations, Alternative 6

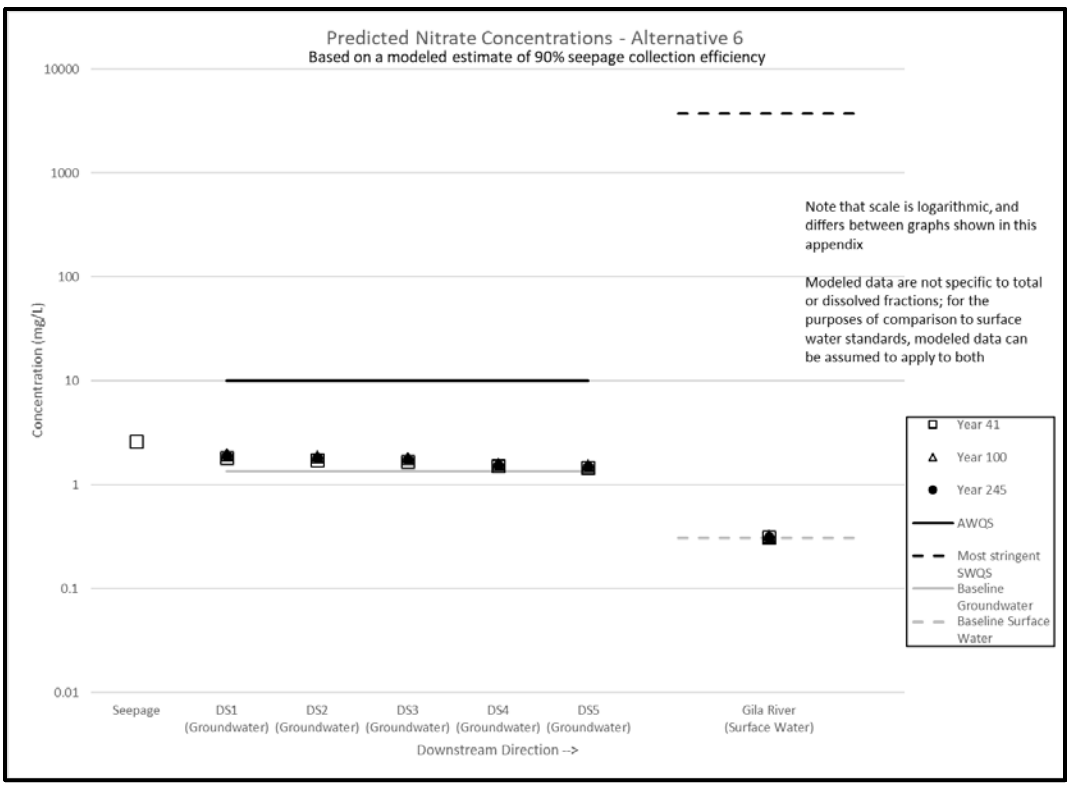

Figure M-34. Predicted nitrate concentrations, Alternative 6

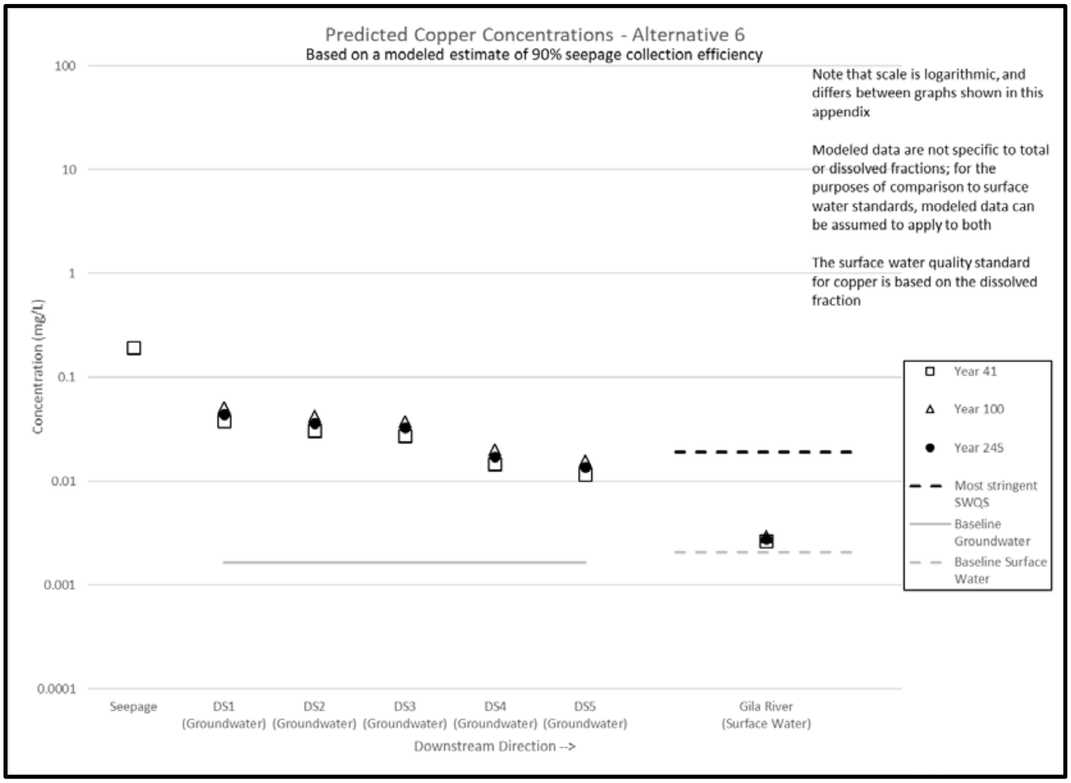

Figure M-35. Predicted copper concentrations, Alternative 6

APPENDIX N. SUMMARY OF EXISTING GROUNDWATER AND SURFACE WATER QUALITY

Overview of Existing Water Quality Sampling

While some water quality samples have been collected in the area as early as 1986, water quality sampling conducted by Resolution Copper Mining, LLC (Resolution Copper) began in earnest in 2003 (Garrett 2017a; Rietz 2016a). Groundwater and surface water quality samples have been analyzed for a wide suite of field parameters, general hydrochemistry, metals, isotopes, and radionuclides. Samples used for the environmental impact statement (EIS) analysis extend through the end of 2015.

Groundwater sampling has focused on wells installed in the Apache Leap Tuff aquifer, the deeper groundwater system, and wells associated solely with shallow alluvium, fracture systems, or perched aquifers (see Garrett 2018b). A separate groundwater investigation associated with voluntary closure and reclamation activities at the West Plant Site also has resulted in a number of water quality samples. In addition to wells, a number of springs have also been sampled; flowing springs are by definition associated with groundwater of some type, though it could be localized or regional in nature.

Surface water sampling has focused on stream systems, notably Devil's Canyon, Arnett Creek, Mineral Creek, and Queen Creek, as well as certain tributaries to these systems (Iron Creek, Hackberry Creek, Oak Flat Wash, Number 9 Wash, Rancho Rio Canyon).

The tables included in this appendix are not a comprehensive database of water quality results, but rather a statistical summary intended to provide an overview of existing groundwater and surface water quality, which forms a baseline for analysis of potential effects.

Summary of Existing Groundwater Quality

Existing groundwater quality data are summarized in Table N-1, for the shallow alluvial or perched groundwater, Apache Leap Tuff aquifer, and deep groundwater system. These data were used as one basis for determining the likely water source for various groundwater-dependent ecosystems (Garrett 2018d).

Summary of Existing Surface Water Quality

The following tables summarize the existing surface water quality data:

- Table N-2. Summary of filtered surface water quality samples for major stream systems in the analysis area. Filtered samples represent dissolved concentrations of constituents.
- Table N-3. Summary of unfiltered surface water quality samples for major stream systems in the analysis area. Unfiltered samples represent total concentrations of constituents.
- Table N-4. Summary of exceedances of Arizona surface water quality standards by existing surface water quality

Table N-1. Summary of existing groundwater quality for shallow alluvial or perched groundwater, Apache Leap Tuff aquifer, and deep groundwater system

		Shallow Groundwater (alluvium or shallow bedrock)					Apache Leap Tuff Aquifer					Deep Groundwater System				
	Units	**Number of Samples**	**Minimum**	**Maximum**	**Mean**	**Median**	**Number of Samples**	**Minimum**	**Maximum**	**Mean**	**Median**	**Number of Samples**	**Minimum**	**Maximum**	**Mean**	**Median**
Electrical Conductivity (Field)	uS/cm	5	208.80	880.00	543.76	525.00	5	479.40	931.00	648.76	560.00	2	513.40	536.10	524.75	524.75
Flow Rate	gpm	1	5.80	5.80	5.80	5.80	1	0.45	0.45	0.45	0.45					
Oxidation-Reduction Potential (Field)	mV											2	65.00	115.00	90.00	90.00
pH (Field)	S.U.	27	5.49	8.21	6.41	6.43	105	6.51	10.17	7.34	7.27	27	6.59	9.75	7.39	7.30
Specific Conductance (Field)	uS/cm	22	199.00	1,020.00	493.54	399.00	100	232.00	736.20	322.84	274.80	25	285.10	4,196.00	1,671.32	1,922.00
Temperature (Field)	C	27	11.11	22.17	17.28	17.10	106	15.00	28.40	24.07	24.20	27	28.80	68.70	43.92	42.70
Turbidity (Field)	NTU						1	4.82	4.82	4.82	4.82					
Carbon 14	PMC	15	85.70	108.50	98.89	97.00	76	55.30	106.29	71.16	67.10	20	0.60	82.45	28.12	24.50
Delta Carbon-13 of DIC	Per mil	15	−20.90	−6.30	−16.75	−18.80	76	−20.10	−7.70	−15.87	−15.80	20	−19.30	−7.30	−13.23	−13.40
Delta Deuterium	Per mil	25	−73.00	−43.00	−60.68	−63.00	92	−79.00	−55.20	−68.80	−69.85	20	−86.00	−67.60	−79.41	−83.05
Delta Oxygen-18 of Sulfate	Per mil	19	−0.70	32.30	8.12	5.60	70	−5.90	23.80	6.24	6.40	16	−1.00	7.60	3.71	3.35
Delta Oxygen-18	Per mil	25	−10.50	−4.61	−8.56	−9.30	92	−11.40	−8.44	−9.92	−9.95	20	−11.96	−9.17	−11.03	−11.51
Delta Sulfur-34	Per mil	20	−5.40	4.60	−0.56	−1.10	70	−3.60	10.00	4.79	4.90	17	−1.20	14.80	5.74	7.70
Strontium 87/86	Ratio	15	0.71	0.72	0.71	0.71	69	0.71	0.73	0.71	0.71	19	0.71	0.72	0.71	0.71
Tritium	T.U.	22	1.22	6.20	3.50	3.25	81	0.30	3.40	1.13	1.00	19	1.00	1.50	1.05	1.00
Alkalinity (as CaCO3)	mg/L	26	11.00	289.00	81.57	66.00	107	73.00	299.00	146.92	140.00	20	110.00	337.00	225.85	245.00
Alkalinity, Phenolphthalein	mg/L	3	6.00	6.00	6.00	6.00	44	6.00	6.00	6.00	6.00	18	6.00	33.00	7.50	6.00
Anions (Laboratory)	meq/L						8	2.82	3.76	3.16	3.04	1	11.46	11.46	11.46	11.46
Bicarbonate (calculated by M&A)	mg/L	26	13.00	353.00	99.40	80.50	107	73.80	365.00	177.44	170.00	20	59.00	411.00	271.10	299.00
Bicarbonate Alkalinity (as CaCO3)	mg/L	26	11.00	289.00	81.57	66.00	107	60.50	299.00	145.42	139.00	20	48.00	337.00	222.25	245.00
Bicarbonate Ion	mg/L	1	117.00	117.00	117.00	117.00										
Carbonate (calculated by M&A)	mg/L	26	0.00	0.00	0.00	0.00	107	0.00	36.50	0.87	0.00	20	0.00	39.00	2.17	0.00
Carbonate Alkalinity (as CaCO3)	mg/L	26	1.00	6.00	5.04	6.00	107	1.00	60.90	6.60	6.00	20	1.00	65.00	8.76	6.00
Cations (Laboratory)	meq/L						8	2.49	3.76	3.01	2.98	1	11.52	11.52	11.52	11.52
Chloride	mg/L	27	3.52	66.70	28.39	27.00	107	4.20	39.90	7.63	5.90	20	5.80	27.00	15.62	17.00
Dissolved oxygen	mg/L	4	1.12	10.61	5.53	5.20	4	1.00	4.60	2.89	2.97					
Fluoride	mg/L	27	0.09	0.48	0.37	0.40	107	0.22	1.05	0.44	0.40	20	0.40	6.26	1.91	0.81
Hardness (as CaCO3)	mg/L	17	76.50	431.00	203.15	170.00	81	63.00	444.00	125.99	92.00	20	6.00	700.00	335.10	255.00
Hydroxide Alkalinity (as CaCO3)	mg/L	21	2.00	6.00	5.81	6.00	87	2.00	6.00	5.82	6.00	19	6.00	6.00	6.00	6.00
Ion Balance (Laboratory)	%						8	−6.21	0.00	−2.58	−2.12	1	0.26	0.26	0.26	0.26
Nitrate as N	mg/L	22	0.20	16.00	2.04	0.20	65	0.20	1.60	0.52	0.51	10	0.20	1.40	0.53	0.28

	Units	Shallow Groundwater (alluvium or shallow bedrock)					Apache Leap Tuff Aquifer					Deep Groundwater System				
		Number of Samples	**Minimum**	**Maximum**	**Mean**	**Median**	**Number of Samples**	**Minimum**	**Maximum**	**Mean**	**Median**	**Number of Samples**	**Minimum**	**Maximum**	**Mean**	**Median**
Nitrate+Nitrite as N (calculated by M&A)	mg/L	22	0.00	16.00	1.93	0.00	65	0.00	1.60	0.52	0.51	10	0.00	1.40	0.43	0.18
Nitrate+Nitrite as N	mg/L	9	0.03	3.63	0.59	0.30	53	0.02	3.46	1.37	2.00	12	0.02	2.00	1.29	2.00
Nitrite as N	mg/L	22	0.10	0.20	0.16	0.20	64	0.10	0.20	0.17	0.20	10	0.03	0.20	0.16	0.20
Ortho-Phosphate	mg/L											1	0.12	0.12	0.12	0.12
pH (Laboratory)	S.U.	24	5.54	8.20	6.82	6.86	98	7.01	9.79	7.74	7.65	19	7.00	9.38	7.63	7.39
Silica	mg/L	25	30.00	52.60	37.19	37.00	106	6.98	88.00	59.34	62.50	20	5.80	87.00	33.31	25.00
Specific Conductance (Laboratory)	uS/cm	24	218.00	1,170.00	519.21	440.00	98	220.00	933.00	332.51	275.00	19	260.00	1,800.00	882.63	570.00
Sulfate	mg/L	27	10.90	547.00	141.63	100.00	107	1.40	228.00	18.07	4.70	20	2.00	840.00	252.28	28.50
Sulfide	mg/L	26	0.04	0.41	0.11	0.04	96	0.04	0.73	0.08	0.05	20	0.02	12.00	0.73	0.05
Temperature (Laboratory)	C	20	17.80	22.20	19.73	19.55	86	17.70	23.00	19.55	19.50	19	17.30	24.10	19.89	19.70
Total Dissolved Solids (calculated by laboratory)	mg/L						8	154.00	275.00	225.25	226.50	1	760.00	760.00	760.00	760.00
Total Dissolved Solids (Laboratory)	mg/L	27	135.00	823.00	364.52	290.00	107	140.00	663.00	247.97	217.00	20	92.00	1,400.00	637.55	410.00
Total Suspended Solids	mg/L	3	10.00	18.00	12.67	10.00	7	10.00	12.00	10.29	10.00	3	5.00	10.00	8.33	10.00
Aluminum	mg/L	26	0.04	1.01	0.21	0.20	107	0.02	0.50	0.21	0.20	20	0.03	4.50	0.40	0.20
Antimony	mg/L	26	0.00	0.00	0.00	0.00	107	0.00	0.02	0.00	0.00	20	0.00	0.06	0.01	0.00
Arsenic	mg/L	26	0.00	0.00	0.00	0.00	107	0.00	0.01	0.00	0.00	20	0.00	0.13	0.01	0.01
Barium	mg/L	26	0.01	0.22	0.08	0.09	107	0.00	0.06	0.02	0.02	20	0.01	0.48	0.08	0.03
Beryllium	mg/L	26	0.00	0.00	0.00	0.00	107	0.00	0.00	0.00	0.00	20	0.00	0.00	0.00	0.00
Boron	mg/L	23	0.04	0.20	0.17	0.20	100	0.03	0.50	0.20	0.20	19	0.07	1.50	0.26	0.20
Bromide	mg/L	26	0.05	0.91	0.48	0.50	97	0.07	1.00	0.49	0.50	20	0.07	0.50	0.42	0.50
Cadmium	mg/L	26	0.00	0.00	0.00	0.00	107	0.00	0.01	0.00	0.00	20	0.00	0.02	0.00	0.00
Calcium	mg/L	27	22.10	130.00	58.33	43.00	107	1.16	130.00	35.22	28.00	20	2.00	270.00	103.16	58.00
Chromium	mg/L	26	0.00	0.01	0.01	0.01	107	0.00	0.01	0.00	0.00	20	0.00	0.61	0.03	0.00
Cobalt	mg/L	23	0.00	0.04	0.01	0.00	100	0.00	0.05	0.00	0.00	19	0.00	0.06	0.00	0.00
Copper	mg/L	26	0.00	0.19	0.02	0.01	107	0.00	0.06	0.01	0.00	20	0.00	1.80	0.10	0.00
Cyanide, Amenable	mg/L	22	0.02	0.05	0.03	0.03	91	0.01	0.05	0.03	0.03	11	0.01	0.05	0.02	0.01
Cyanide, Free	mg/L											1	0.10	0.10	0.10	0.10
Cyanide, Total	mg/L	4	0.00	0.00	0.00	0.00	5	0.00	0.01	0.01	0.00	8	0.00	0.05	0.02	0.01
Cyanide, weak acid dissociable	mg/L											1	0.01	0.01	0.01	0.01
Iron	mg/L	26	0.05	30.00	4.53	0.39	107	0.02	10.00	0.65	0.13	20	0.05	1,100.00	59.07	2.05
Lead	mg/L	26	0.00	0.02	0.00	0.00	107	0.00	0.01	0.00	0.00	20	0.00	0.43	0.02	0.00
Lithium	mg/L											1	0.10	0.10	0.10	0.10
Magnesium	mg/L	27	2.60	38.10	11.88	9.90	107	0.04	28.80	6.39	4.70	20	0.25	43.00	19.33	20.00
Manganese	mg/L	23	0.00	2.06	0.42	0.30	100	0.00	1.30	0.11	0.03	20	0.01	15.00	0.94	0.16
Mercury	mg/L	25	0.00	0.00	0.00	0.00	105	0.00	0.00	0.00	0.00	20	0.00	0.00	0.00	0.00

	Units	Shallow Groundwater (alluvium or shallow bedrock)					Apache Leap Tuff Aquifer					Deep Groundwater System				
		Number of Samples	Minimum	Maximum	Mean	Median	Number of Samples	Minimum	Maximum	Mean	Median	Number of Samples	Minimum	Maximum	Mean	Median
Molybdenum	mg/L	26	0.00	0.02	0.01	0.01	107	0.00	0.05	0.01	0.00	20	0.00	0.27	0.03	0.02
Nickel	mg/L	26	0.00	0.02	0.01	0.01	107	0.00	0.14	0.01	0.00	20	0.00	0.22	0.02	0.00
Potassium	mg/L	27	0.76	4.37	2.34	2.00	107	0.95	5.80	1.97	2.00	20	2.00	39.00	14.36	6.10
Selenium	mg/L	26	0.00	0.02	0.00	0.00	107	0.00	0.02	0.00	0.00	20	0.00	0.04	0.00	0.00
Silicon	mg/L	1	40.00	40.00	40.00	40.00	1	59.00	59.00	59.00	59.00					
Silver	mg/L	26	0.00	0.00	0.00	0.00	107	0.00	0.01	0.00	0.00	20	0.00	0.02	0.00	0.00
Sodium	mg/L	27	7.00	131.00	29.73	22.00	107	16.00	69.30	28.29	25.00	20	13.00	160.00	72.10	33.00
Strontium (by isotope dilution)	mg/L	15	0.17	1.25	0.44	0.29	69	0.09	0.52	0.18	0.15	19	0.03	41.83	5.16	0.61
Strontium	mg/L											1	0.76	0.76	0.76	0.76
Thallium	mg/L	26	0.00	0.00	0.00	0.00	107	0.00	0.01	0.00	0.00	20	0.00	0.02	0.00	0.00
Uranium	mg/L	12	0.00	0.00	0.00	0.00	62	0.00	0.02	0.00	0.00	20	0.00	0.01	0.00	0.00
Zinc	mg/L	26	0.01	1.04	0.15	0.06	107	0.01	1.97	0.26	0.08	20	0.01	1.70	0.16	0.05
Gross Alpha, Adjusted	pCi/L						34	−10.70	7.00	−0.55	−0.11	17	−13.70	49.00	5.24	0.01
Gross Alpha	pCi/L	14	1.00	18.00	4.58	2.10	64	1.00	10.00	2.66	2.00	20	1.80	49.00	13.73	3.20
Gross Beta	pCi/L	14	2.00	14.00	4.62	2.80	64	2.00	9.70	3.68	3.80	20	2.60	56.00	20.17	9.40
Radium 226 + Radium 228	pCi/L	14	0.00	3.39	1.03	0.45	64	0.00	2.70	0.44	0.00	20	0.00	16.00	4.56	1.07
Radium 226	pCi/L	14	0.10	0.60	0.28	0.23	64	0.08	0.69	0.22	0.19	20	0.20	11.00	3.53	0.65
Radium 228	pCi/L	14	0.85	2.80	1.53	1.20	64	0.54	2.70	1.33	1.20	20	0.57	5.30	1.57	1.00
Radon 222	pCi/L						5	130.00	530.00	360.00	470.00	4	24.00	2,400.00	1,781.00	2,350.00
U-234/U-238	Ratio						28	0.40	8.70	2.73	2.25	5	0.60	14.00	6.26	2.80
Uranium 234	pCi/L	12	0.20	0.20	0.20	0.20	63	0.20	7.30	1.62	1.20	19	0.20	46.00	6.41	1.10
Uranium 235	pCi/L	12	0.20	0.20	0.20	0.20	63	0.10	1.30	0.67	0.97	19	0.10	5.00	1.22	0.99
Uranium 238	pCi/L	12	0.20	0.20	0.20	0.20	63	0.20	5.32	1.04	1.00	19	0.10	6.29	1.76	1.10
Uranium Activity (Calc 200_8)	pCi/L						2	0.20	6.10	3.15	3.15					
Uranium Activity (Calc 907_0)	pCi/L	12	0.20	0.20	0.20	0.20	29	0.20	6.40	1.50	1.10	2	0.20	0.30	0.25	0.25

Notes: M&A = Montgomery & Associates

Units: C = degrees Celsius; gpm = gallons per minute; mg/L = milligrams per liter; meq/L = milliequivalents per liter; mV = millivolts; NTU = Nephelometric Turbidity Units; pCi/L = picocuries per liter; per mil = parts per thousand PMC = percent modern carbon; ratio = mathematical comparison of two strontium isotopes; S.U. = standard units; T.U. = tritium units; uS/cm = microSiemens per centimeter

The database of groundwater quality results is extensive; this table is meant to be a summary and necessarily requires assumptions about processing and using reported data. The following assumptions were used when compiling and assessing the data:

1) For any samples reported as less than the detection limit, concentrations were set to the detection limit. While other methods could be used (such as setting these values to zero), this method specifically avoids underreporting concentrations.
2) For any samples reported as simply "non-detect," without a quantified detection limit, concentrations were set to zero.
3) Samples reported with certain data qualifiers were not used. These include samples reported with insufficient sample amount, data not usable, or lost samples.
4) The database used to compile this table utilized all available data, regardless of whether the sample had been filtered or not. Therefore this table includes reported results for total, total recoverable, and dissolved concentrations. This method was deemed appropriate because Arizona aquifer water quality standards are not specific to total or dissolved concentrations, unlike Arizona surface water quality standards.

Table N-2. Summary of filtered surface water quality samples for major stream systems in the analysis area

		Upper Devil's Canyon				Middle Devil's Canyon				Lower Devil's Canyon				Upper Queen Creek				Lower Queen Creek				Mineral Creek			
Parameter	**Units**	**Max**	**Range**	**Avg**	**Median**	**Max**	**Range**	**Avg**	**Median**	**Max**	**Range**	**Avg**	**Median**	**Max**	**Range**	**Avg**	**Median**	**Max**	**Range**	**Avg**	**Median**	**Max**	**Range**	**Avg**	**Median**
Alkalinity (as CaCO3)	mg/L	50.3	38.8	26.1	16.4	135.0	20.0	125.0	125.0					262.0	153.0	182.3	176.0	137.0	0.0	137.0	137.0				
Bicarbonate Alkalinity (as CaCO3)	mg/L	50.3	38.8	26.1	16.4	135.0	21.0	124.5	124.5					262.0	153.0	182.3	176.0	137.0	0.0	137.0	137.0				
Carbonate Alkalinity (as CaCO3)	mg/L	1.0	0.0	1.0	1.0	1.6	0.6	1.3	1.3					1.0	0.0	1.0	1.0	1.0	0.0	1.0	1.0				
Chloride	mg/L	14.6	11.7	7.6	5.4	9.5	2.5	8.3	8.3					33.6	24.8	17.9	11.3	12.6	0.0	12.6	12.6				
Dissolved Organic Carbon	mg/L	8.1	1.9	7.1	7.0	2.0	0.0	2.0	2.0					10.4	5.7	8.0	8.5					7.1	5.4	3.3	2.8
Fluoride	mg/L	0.18	0.08	0.13	0.10	0.42	0.21	0.29	0.23					0.13	0.01	0.12	0.12								
Hardness (as CaCO3)	mg/L	47.8	36.0	26.8	19.3	87.9	69.6	65.3	85.0					311.0	251.4	195.1	187.0	69.4	20.4	59.2	59.2	363.0	173.0	250.6	196.0
Silica	mg/L	54.8	36.6	33.3	32.1	73.2	51.9	46.9	43.7	47.4	16.8	36.9	32.7	51.2	51.0	25.2	25.4	39.3	32.1	26.2	23.8	64.0	34.5	47.5	42.9
Sulfate	mg/L	8.6	7.9	3.3	0.7	3.5	0.8	3.1	3.1					29.6	15.7	19.9	16.2	56.9	0.0	56.9	56.9				
Aluminum	mg/L	2.200	2.186	0.192	0.080	0.165	0.151	0.072	0.080	0.080	0.040	0.067	0.080	0.200	0.178	0.076	0.080	0.790	0.776	0.177	0.080	0.200	0.186	0.066	0.080
Antimony	mg/L	0.006	0.006	0.003	0.003	0.006	0.006	0.003	0.003	0.003	0.003	0.003	0.003	0.015	0.014	0.003	0.003	0.003	0.002	0.002	0.002	0.003	0.003	0.002	0.003
Arsenic	mg/L	0.025	0.024	0.012	0.007	0.025	0.024	0.012	0.007	0.025	0.022	0.008	0.004	0.051	0.047	0.023	0.025	0.027	0.025	0.017	0.024	0.037	0.036	0.020	0.025
Barium	mg/L	0.054	0.052	0.015	0.012	0.043	0.032	0.022	0.023	0.054	0.041	0.028	0.025	0.075	0.064	0.039	0.036	0.044	0.031	0.028	0.034	0.054	0.025	0.039	0.037
Beryllium	mg/L	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.001	0.001	0.002	0.002	0.001	0.001
Boron	mg/L	0.040	0.025	0.032	0.040	0.040	0.031	0.021	0.014	0.009	0.000	0.009	0.009	0.200	0.180	0.087	0.040	0.068	0.051	0.049	0.061	0.200	0.187	0.064	0.021
Bromide	mg/L	0.350	0.250	0.176	0.120	0.150	0.050	0.123	0.120					0.240	0.100	0.190	0.190								
Cadmium	mg/L	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005	0.005	0.000	0.000	0.001	0.001	0.000	0.000	0.001	0.001	0.000	0.000
Calcium	mg/L	13.0	9.2	7.6	6.2	26.6	2.7	25.3	25.3					89.0	46.0	64.7	63.5	57.0	40.0	37.0	37.0	54.0	0.0	54.0	54.0
Chromium	mg/L	0.006	0.006	0.005	0.006	0.006	0.006	0.005	0.006	0.006	0.006	0.005	0.006	0.006	0.006	0.005	0.006	0.010	0.009	0.002	0.001	0.001	0.000	0.001	0.001
Cobalt	mg/L	0.006	0.005	0.005	0.006	0.006	0.005	0.004	0.006	0.006	0.004	0.005	0.006	0.006	0.005	0.005	0.006	0.010	0.009	0.004	0.004	0.006	0.005	0.004	0.006
Copper	mg/L	0.028	0.027	0.007	0.005	0.013	0.012	0.004	0.002	0.010	0.009	0.005	0.003	0.051	0.050	0.009	0.007	0.062	0.060	0.020	0.020	0.013	0.012	0.002	0.001
Iron	mg/L	3.640	3.580	0.400	0.128	0.115	0.095	0.057	0.060	0.060	0.012	0.056	0.060	0.180	0.160	0.060	0.060	0.560	0.540	0.114	0.060	0.230	0.212	0.059	0.060
Lead	mg/L	0.003	0.003	0.002	0.003	0.003	0.003	0.001	0.000	0.003	0.003	0.002	0.003	0.005	0.005	0.001	0.000	0.005	0.005	0.001	0.000	0.003	0.003	0.000	0.000
Magnesium	mg/L	3.4	2.2	2.0	1.6	5.6	0.2	5.5	5.5					18.0	9.5	14.3	15.4	12.4	10.3	7.2	7.2	15.0	0.0	15.0	15.0
Manganese	mg/L	0.824	0.820	0.113	0.019	0.032	0.031	0.010	0.008	0.252	0.250	0.086	0.004	2.600	2.598	0.184	0.030	0.500	0.496	0.077	0.010	0.136	0.134	0.029	0.010
Mercury, Low Level	ng/l	12.0	11.3	4.0	1.6	1.0	0.5	0.6	0.5					2.5	1.8	1.4	1.1	0.9	0.0	0.9	0.9	0.5	0.0	0.5	0.5
Mercury	mg/L	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0001	0.0000	0.0002	0.0002	0.0001	0.0001
Molybdenum	mg/L	0.008	0.008	0.006	0.008	0.028	0.026	0.007	0.008	0.008	0.003	0.007	0.008	0.049	0.047	0.011	0.008	0.020	0.019	0.007	0.007	0.012	0.010	0.007	0.008
Nickel	mg/L	0.010	0.009	0.006	0.010	0.010	0.009	0.005	0.004	0.010	0.009	0.007	0.010	0.010	0.009	0.005	0.003	0.010	0.009	0.002	0.002	0.010	0.009	0.003	0.002
Potassium	mg/L	2.5	0.6	2.2	2.3	2.4	0.8	1.9	1.9					7.6	4.5	4.6	3.8	4.2	0.0	4.2	4.2	2.0	0.0	2.0	2.0
Selenium	mg/L	0.001	0.000	0.001	0.001	0.001	0.000	0.000	0.001	0.001	0.000	0.001	0.001	0.010	0.009	0.003	0.001	0.002	0.002	0.001	0.001	0.002	0.001	0.001	0.001
Silver	mg/L	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005	0.005	0.000	0.000	0.001	0.001	0.000	0.000	0.001	0.001	0.000	0.000
Sodium	mg/L	9.0	4.9	5.8	4.3	21.9	4.9	19.4	19.4					27.0	18.3	17.6	17.3	14.5	0.0	14.5	14.5	24.0	0.0	24.0	24.0
Strontium	mg/L	0.143	0.122	0.056	0.040	0.190	0.159	0.123	0.140					0.364	0.314	0.182	0.175	0.200	0.131	0.135	0.135	0.349	0.169	0.275	0.272
Thallium	mg/L	0.002	0.002	0.001	0.001	0.002	0.002	0.001	0.001	0.002	0.002	0.001	0.002	0.005	0.005	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001

		Upper Devil's Canyon				Middle Devil's Canyon				Lower Devil's Canyon				Upper Queen Creek				Lower Queen Creek				Mineral Creek			
Parameter	**Units**	**Max**	**Range**	**Avg**	**Median**	**Max**	**Range**	**Avg**	**Median**	**Max**	**Range**	**Avg**	**Median**	**Max**	**Range**	**Avg**	**Median**	**Max**	**Range**	**Avg**	**Median**	**Max**	**Range**	**Avg**	**Median**
Zinc	mg/L	0.024	0.023	0.008	0.010	0.010	0.010	0.007	0.010	0.010	0.010	0.008	0.010	0.050	0.050	0.009	0.010	0.050	0.048	0.010	0.010	2.600	2.598	0.073	0.010

Units: mg/L = milligrams per liter; ng//L = nanograms per liter

The database of groundwater quality results is extensive; this table is meant to be a summary and necessarily requires assumptions about processing and using reported data. The following assumptions were used when compiling and assessing the data:

1) For any samples reported as less than the detection limit, concentrations were set to the detection limit. While other methods could be used (such as setting these values to zero), this method specifically avoids underreporting concentrations.
2) For any samples reported as simply "non-detect," without a quantified detection limit, concentrations were set to zero.
3) Samples reported with certain data qualifiers were not used. These include samples reported with insufficient sample amount, data not usable, or lost samples.

Table N-3. Summary of unfiltered surface water quality samples for major stream systems in the analysis area

		Upper Devil's Canyon				Middle Devil's Canyon				Lower Devil's Canyon				Upper Queen Creek				Lower Queen Creek				Mineral Creek			
Parameter	**Units**	**Max**	**Range**	**Avg**	**Median**	**Max**	**Range**	**Avg**	**Median**	**Max**	**Range**	**Avg**	**Median**	**Max**	**Range**	**Avg**	**Median**	**Max**	**Range**	**Avg**	**Median**	**Max**	**Range**	**Avg**	**Median**
E. coli	MPN/100ml	1,600	1,598	234	3	900	898	65	5	50	48	9	3	900	898	106	2	99		99	99				
Total Coliforms	MPN/100ml	1,600	1,592	682	170	1,600	1,579	457	185	1,600	1,589	315	130	1,600	1,588	766	300	2,420		2,420	2,420				
Alkalinity (as CaCO3)	mg/L	81.5	77.4	23.7	17.0	177.0	167.3	109.7	116.5	225.0	206.9	124.9	129.0	333.0	280.5	175.8	170.0	287.0	249.5	132.5	84.0	364.0	222.0	245.2	206.0
Bicarbonate Alkalinity (as CaCO3)	mg/L	81.5	77.4	23.7	17.0	177.0	167.3	109.5	116.0	225.0	206.9	124.9	129.0	381.0	328.5	177.1	170.0	287.0	249.5	132.1	84.0	364.0	222.0	244.1	203.5
Carbonate Alkalinity (as CaCO3)	mg/L	6.0	5.0	1.1	1.0	8.3	7.3	1.2	1.0	1.0	0.0	1.0	1.0	27.5	26.5	2.2	1.0	6.0	5.0	2.7	1.0	8.4	7.4	1.9	1.0
Chloride	mg/L	27.3	25.4	8.3	6.4	12.4	9.6	7.6	7.4	11.4	8.0	8.4	8.7	43.0	39.7	13.7	12.4	28.8	26.8	12.6	7.5	20.5	14.5	13.7	12.5
Fluoride	mg/L	0.57	0.49	0.14	0.10	0.56	0.46	0.24	0.23	0.24	0.14	0.17	0.17	0.40	0.30	0.17	0.14	0.50	0.40	0.25	0.18	0.53	0.36	0.32	0.31
Hardness (as CaCO3)	mg/L	92.0	91.9	18.1	0.5	46.0	45.9	7.5	0.3	37.0	36.8	8.5	5.0	74.0	73.9	6.8	0.2	0.5	0.4	0.3	0.2	0.5	0.4	0.3	0.3
Nitrate as N	mg/L	2.5	2.4	0.4	0.2	1.0	0.9	0.2	0.1	0.2	0.1	0.1	0.1	5.6	5.5	0.7	0.2	4.6	3.9	2.4	1.9	0.4	0.2	0.3	0.3
Nitrite as N	mg/L	1.0	0.9	0.1	0.1	1.0	0.9	0.1	0.1	0.1	0.0	0.1	0.1	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.0	0.2	0.0	0.2	0.2
Nitrate+Nitrite as N	mg/L	2.5	2.4	0.4	0.2	2.0	2.0	0.3	0.2	0.2	0.1	0.2	0.2	2.1	2.0	0.7	0.3	1.9	1.2	1.5	1.8	2.0	1.9	0.6	0.4
Ortho-Phosphate	mg/L	5.0	4.5	0.7	0.5	0.5	0.0	0.5	0.5	0.5	0.0	0.5	0.5	0.5	0.0	0.5	0.5								
pH (Laboratory)	S.U.	7.0	0.1	7.0	7.0	8.1	0.3	7.9	7.9	8.1	0.0	8.1	8.1	8.0	0.2	7.9	7.9	8.4	0.7	8.0	7.9	8.4	0.8	8.0	8.0
Silica	mg/L	53.6	40.7	30.5	31.0	82.3	57.3	52.1	50.7	53.8	26.4	41.4	43.1	69.7	42.6	40.4	40.0	120.0	96.0	51.5	45.1	62.9	23.6	51.8	52.5
Specific Conductance (Laboratory)	uS/cm	133	52	107	107	333	60	309	316	300	0	300	300	650	288	506	506	860	720	554	789	704	315	514	481
Sulfate	mg/L	58.0	57.7	13.0	10.6	71.1	70.6	9.3	6.6	41.6	30.7	19.7	15.6	70.7	62.4	31.1	27.9	150.0	143.0	60.4	35.4	103.0	86.1	51.5	49.7
Sulfide	mg/L	1.00	0.61	0.97	1.00	1.00	0.61	0.89	1.00	1.00	0.61	0.93	1.00	1.00	0.95	0.90	1.00	0.39	0.00	0.39	0.39	1.10	1.05	0.69	0.81
Total Dissolved Solids (Laboratory)	mg/L	224	194	101	96	320	247	177	182	321	232	202	200	473	353	270	250	580	458	296	207	498	247	368	344
Total Suspended Solids	mg/L	171	166	16	5	11	6	6	5	5	0	5	5	173	168	18	5	10	5	7	6	2,630	2,625	78	5
Gross Alpha	pCi/L	20.8	19.8	4.4	1.6	3.9	2.4	2.4	2.3	2.0	0.0	2.0	2.0	4.7	2.8	2.8	2.5	5.9	1.6	5.1	5.1	7.5	5.8	3.5	3.0
Gross Beta	pCi/L	18.4	15.8	5.7	4.0	4.3	1.6	3.7	3.7	4.1	0.0	4.1	4.1	6.2	3.3	4.0	3.4	14.0	9.8	9.1	9.1	8.1	6.5	4.1	4.0
Aluminum	mg/L	2.5	2.5	0.5	0.2	0.9	0.9	0.1	0.0	0.7	0.6	0.1	0.0	9.3	9.3	0.7	0.0	67.0	66.8	11.1	1.2	0.2	0.1	0.1	0.1
Antimony	mg/L	0.006	0.006	0.003	0.003	0.006	0.006	0.003	0.003	0.003	0.003	0.002	0.003	0.015	0.015	0.003	0.003	0.004	0.004	0.002	0.002	0.015	0.015	0.002	0.003
Arsenic	mg/L	0.038	0.037	0.012	0.006	0.025	0.024	0.011	0.005	0.025	0.022	0.008	0.005	0.045	0.041	0.024	0.025	0.072	0.071	0.021	0.025	0.043	0.042	0.017	0.025
Barium	mg/L	0.036	0.031	0.014	0.012	0.041	0.033	0.024	0.023	0.054	0.037	0.033	0.026	0.078	0.076	0.036	0.028	0.380	0.364	0.061	0.028	0.857	0.828	0.072	0.040
Beryllium	mg/L	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.004	0.003	0.001	0.001	0.005	0.005	0.002	0.002

		Upper Devil's Canyon				Middle Devil's Canyon				Lower Devil's Canyon				Upper Queen Creek				Lower Queen Creek				Mineral Creek			
Parameter	**Units**	**Max**	**Range**	**Avg**	**Median**	**Max**	**Range**	**Avg**	**Median**	**Max**	**Range**	**Avg**	**Median**	**Max**	**Range**	**Avg**	**Median**	**Max**	**Range**	**Avg**	**Median**	**Max**	**Range**	**Avg**	**Median**
Boron	mg/L	0.040	0.033	0.035	0.040	0.040	0.033	0.033	0.040	0.040	0.033	0.034	0.040	0.200	0.193	0.044	0.040	0.082	0.059	0.050	0.040	0.200	0.186	0.041	0.040
Bromide	mg/L	0.470	0.387	0.136	0.100	0.573	0.503	0.118	0.100	0.190	0.130	0.117	0.100	1.110	1.040	0.215	0.160	0.500	0.449	0.158	0.106	0.500	0.420	0.141	0.115
Cadmium	mg/L	0.002	0.002	0.001	0.000	0.005	0.005	0.001	0.000	0.002	0.002	0.000	0.000	0.005	0.005	0.001	0.002	0.004	0.004	0.001	0.001	0.005	0.005	0.002	0.002
Calcium	mg/L	22.3	19.2	9.3	7.3	41.4	36.3	24.2	25.9	55.9	48.1	32.0	30.2	112.0	93.6	58.3	56.1	210.0	191.9	65.4	35.9	95.1	51.1	68.8	60.9
Chromium	mg/L	0.006	0.006	0.005	0.006	0.006	0.006	0.005	0.006	0.006	0.006	0.005	0.006	0.006	0.006	0.005	0.006	0.071	0.071	0.009	0.006	0.058	0.058	0.006	0.006
Cobalt	mg/L	0.006	0.005	0.005	0.006	0.006	0.005	0.005	0.006	0.006	0.005	0.005	0.006	0.006	0.005	0.005	0.006	0.028	0.028	0.005	0.001	0.005	0.004	0.002	0.001
Copper	mg/L	0.088	0.087	0.012	0.010	0.015	0.014	0.007	0.010	0.011	0.009	0.007	0.010	0.144	0.141	0.015	0.010	0.680	0.677	0.074	0.023	0.702	0.701	0.025	0.010
Cyanide, Amenable	mg/L													0.008	0.000	0.008	0.008					0.008	0.000	0.008	0.008
Cyanide, Free	mg/L	0.100	0.000	0.100	0.100	0.100	0.000	0.100	0.100					0.100	0.000	0.100	0.100								
Cyanide, Total	mg/L	0.010	0.005	0.009	0.010	0.010	0.006	0.007	0.005	0.010	0.006	0.007	0.007	0.010	0.005	0.008	0.010	0.005	0.000	0.005	0.005	0.004	0.000	0.004	0.004
Iron	mg/L	8.260	8.200	1.299	0.436	0.454	0.430	0.128	0.094	0.328	0.304	0.090	0.060	5.110	5.097	0.418	0.048	56.000	55.730	9.374	1.210	0.337	0.283	0.157	0.119
Lead	mg/L	0.010	0.010	0.003	0.003	0.005	0.005	0.003	0.003	0.005	0.005	0.003	0.003	0.022	0.021	0.003	0.003	0.380	0.380	0.031	0.003	0.222	0.222	0.008	0.003
Magnesium	mg/L	6.3	5.3	2.6	2.0	8.8	7.5	5.1	5.3	11.4	9.6	6.6	6.3	23.7	20.4	11.7	11.5	29.0	25.6	13.6	8.7	36.1	26.0	21.0	16.5
Manganese	mg/L	1.060	1.056	0.147	0.064	0.137	0.133	0.023	0.014	0.276	0.275	0.043	0.013	2.700	2.696	0.212	0.086	3.900	3.896	0.384	0.016	8.230	8.226	0.259	0.017
Mercury	mg/L	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Molybdenum	mg/L	0.008	0.008	0.007	0.008	0.008	0.005	0.007	0.008	0.009	0.007	0.007	0.008	0.014	0.011	0.009	0.009	0.010	0.009	0.003	0.003	0.005	0.002	0.003	0.003
Nickel	mg/L	0.010	0.009	0.008	0.010	0.010	0.008	0.008	0.010	0.010	0.009	0.008	0.010	0.010	0.009	0.009	0.010	0.047	0.046	0.009	0.006	0.114	0.113	0.010	0.010
Potassium	mg/L	8.8	7.7	2.3	2.0	3.1	2.1	1.7	1.5	3.7	2.2	2.2	2.1	7.6	6.2	3.8	3.3	17.0	15.5	3.9	3.0	19.9	19.2	1.8	1.4
Selenium	mg/L	0.005	0.005	0.002	0.003	0.006	0.006	0.002	0.001	0.003	0.003	0.002	0.003	0.010	0.010	0.002	0.001	0.004	0.004	0.001	0.001	0.010	0.010	0.001	0.001
Silver	mg/L	0.005	0.005	0.002	0.000	0.005	0.005	0.002	0.000	0.005	0.005	0.001	0.000	0.005	0.005	0.003	0.005	0.005	0.005	0.003	0.002	0.005	0.005	0.003	0.005
Sodium	mg/L	13.2	10.0	6.7	6.0	30.9	26.4	19.8	19.1	32.2	26.5	19.9	19.3	28.0	23.6	13.1	14.6	46.3	44.1	18.4	11.1	36.5	22.9	27.8	26.9
Strontium (by isotope dilution)	ppm	0.100	0.075	0.048	0.045	0.161	0.070	0.127	0.120					0.310	0.174	0.210	0.205	0.204	0.000	0.204	0.204	0.369	0.183	0.274	0.266
Thallium	mg/L	0.002	0.002	0.001	0.001	0.002	0.002	0.001	0.001	0.002	0.002	0.001	0.002	0.005	0.005	0.001	0.001	0.002	0.002	0.001	0.001	0.005	0.005	0.001	0.001
Uranium	mg/L	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.001	0.001	0.001	0.005	0.005	0.003	0.003	0.004	0.004	0.002	0.002
Zinc	mg/L	0.020	0.018	0.008	0.010	0.016	0.015	0.007	0.010	0.020	0.018	0.008	0.010	0.090	0.089	0.012	0.010	1.300	1.297	0.105	0.010	0.784	0.783	0.028	0.010
Radium 226 + Radium 228	pCi/L	1.40	1.40	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.10	1.10	0.33	0.00	0.00	0.00	0.00	0.00	1.30	1.30	0.15	0.00
Radium 226	pCi/L	1.00	0.81	0.43	0.35	1.10	0.90	0.44	0.35	0.30	0.00	0.30	0.30	0.90	0.70	0.50	0.41	0.26	0.05	0.23	0.23	0.26	0.20	0.18	0.20
Radium 228	pCi/L	1.50	0.30	1.38	1.40	1.50	0.30	1.37	1.40	1.40	0.00	1.40	1.40	1.50	0.40	1.28	1.20	1.40	0.20	1.30	1.30	1.50	0.92	1.11	1.10

* mg/L = milligrams per liter; MPN/100ml = most probable number per 100 milliliters; pCi/L = picocuries per liter; ppm = parts per million; S.U. = standard unit; uS/cm = microSiemens per centimeter

The database of groundwater quality results is extensive; this table is meant to be a summary and necessarily requires assumptions about processing and using reported data. The following assumptions were used when compiling and assessing the data:

1) For any samples reported as less than the detection limit, concentrations were set to the detection limit. While other methods could be used (such as setting these values to zero), this method specifically avoids underreporting concentrations.
2) For any samples reported as simply "non-detect," without a quantified detection limit, concentrations were set to zero.
3) Samples reported with certain data qualifiers were not used. These include samples reported with insufficient sample amount, data not usable, or lost samples.

Table N-4 summarizes the number of samples that were identified as exceeding Arizona surface water quality standards. Grayed areas indicate that no standard exists, for either that chemical constituent or for the specific water use (Arizona Administrative Code, R18-11 Article 1). Cited standards for constituents that are not based on the hardness of the water are shown in bold at the head of each constituent section. Where no standard is listed, the applicable standard is based upon the hardness of the water (the amount of calcium and magnesium in the water) and is variable.

Table N-4. Summary of exceedances of Arizona surface water quality standards by existing surface water quality

		Number of Exceedances by Major Stream System, for Arizona Surface Water Quality Standards									
PARAMETER	**Stream System**	**DWS**	**FC**	**PBC**	**FBC**	**A&Ww Acute**	**A&Ww Chronic**	**A&We Acute**	**A&W edw Acute**	**A&W edw Chronic**	**AgL**
		mg/L	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
Gross Alpha pCi/L		**15**									
	Upper Devil's Canyon	1									
	Middle Devil's Canyon	0									
	Lower Devil's Canyon	0									
	Upper Queen Creek	0									
	Lower Queen Creek	0									
	Mineral Creek	0									
Antimony		**0.006 T**	**0.640 T**	**0.747 T**		**0.088 D**	**0.030 D**				
	Upper Devil's Canyon	3	0	0		0	0				
	Middle Devil's Canyon	2	0	0		0	0				
	Lower Devil's Canyon	0	0	0		0	0				
	Upper Queen Creek	2		0		0	0				
	Lower Queen Creek	0	0	0	0	0	0				
	Mineral Creek	1	0		0	0	0				
Arsenic		**0.010 T**	**0.0080 T**	**0.280 T**		**0.340 D**	**0.150 D**	**0.440 D**			**0.200 T**
	Upper Devil's Canyon	20	21	0		0	0	0			0
	Middle Devil's Canyon	16	18	0		0	0	0			0
	Lower Devil's Canyon	2	2	0		0	0	0			0
	Upper Queen Creek	38	38	0		0	0	0			0
	Lower Queen Creek	10	10	0		0	0	0			0
	Mineral Creek	25	25	0		0	0	0			0
Barium		**2.0 T**		**98.0 T**							
	Upper Devil's Canyon	0		0							
	Middle Devil's Canyon	0		0							
	Lower Devil's Canyon	0		0							
	Upper Queen Creek	0		0							
	Lower Queen Creek	0		0							
	Mineral Creek	0		0							
Beryllium		**0.004 T**	**0.084 T**	**1.867 T**							
	Upper Devil's Canyon	0	0	0							
	Middle Devil's Canyon	0	0	0							
	Lower Devil's Canyon	0	0	0							
	Upper Queen Creek	0	0	0							
	Lower Queen Creek	0	0	0							
	Mineral Creek	1	0	0							

		Number of Exceedances by Major Stream System, for Arizona Surface Water Quality Standards									
PARAMETER	Stream System	DWS	FC	PBC	FBC	A&Ww Acute	A&Ww Chronic	A&We Acute	A&W edw Acute	A&W edw Chronic	AgL
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Boron		**1.400 T**		**186.667 T**							**1.000 T**
	Upper Devil's Canyon	0		0							0
	Middle Devil's Canyon	0		0							0
	Lower Devil's Canyon	0		0							0
	Upper Queen Creek	0		0							0
	Lower Queen Creek	0		0							0
	Mineral Creek	0		0							0
Cadmium		**0.005 T**	**0.084 T**	**0.700 T**	**0.700 T**						**50 T**
	Upper Devil's Canyon	0	0	0	0	9	24				0
	Middle Devil's Canyon	0	0	0	0	0	2				0
	Lower Devil's Canyon	0	0	0	0	3	21				0
	Upper Queen Creek	0	0	0	0	0	1				0
	Lower Queen Creek	0	0	0	0	1	2		1	2	0
	Mineral Creek	0	0	0	0	0	1				0
Chromium III			**75.000 T**	**1,400 T**	**1,400 T**						
	Upper Devil's Canyon		ND	ND	ND	ND	ND				
	Middle Devil's Canyon		ND	ND	ND	ND	ND				
	Lower Devil's Canyon		ND	ND	ND	ND	ND				
	Upper Queen Creek		ND	ND	ND	ND	ND				
	Lower Queen Creek		ND	ND	ND	ND	ND		ND	ND	
	Mineral Creek		ND	ND	ND	ND	ND				
Chromium VI		**0.021 T**	**0.150 T**	**2.800 T**	**2.800 T**	**0.016 D**	**0.011 D**	**0.034 D**			
	Upper Devil's Canyon	ND	ND	ND	ND	ND	ND	ND			
	Middle Devil's Canyon	ND	ND	ND	ND	ND	ND	ND			
	Lower Devil's Canyon	ND	ND	ND	ND	ND	ND	ND			
	Upper Queen Creek	ND	ND	ND	ND	ND	ND	ND			
	Lower Queen Creek	ND	ND	ND	ND	ND	ND	ND			
	Mineral Creek	ND	ND	ND	ND	ND	ND	ND			
Chromium (Total)		**0.100 T**									**1 T**
	Upper Devil's Canyon	0									0
	Middle Devil's Canyon	0									0
	Lower Devil's Canyon	0									0
	Upper Queen Creek	0									0
	Lower Queen Creek	0									0
	Mineral Creek	0									0
Copper		**1.300 T**		**1.300 T**	**1.300 T**						**0.500 T**

PARAMETER	Stream System	Number of Exceedances by Major Stream System, for Arizona Surface Water Quality Standards									
		DWS	FC	PBC	FBC	A&Ww Acute	A&Ww Chronic	A&We Acute	A&W edw Acute	A&W edw Chronic	AgL
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
	Upper Devil's Canyon	0		0		29	33				0
	Middle Devil's Canyon	0		0		7	10				0
	Lower Devil's Canyon	0		0		31	40				0
	Upper Queen Creek	0		0		4	8		4	8	0
	Lower Queen Creek	0		0	0	13	18				1
	Mineral Creek	0			0	0	0				1
Cyanide (as free cyanide)		**0.200 T**	**16.000 T**	**18.667 T**	**18.667 T**	**0.041 T**	**0.0097 T**	**0.084 T**			**0.200 T**
	Upper Devil's Canyon	0	0	0		3	3	3			0
	Middle Devil's Canyon	0	0	0		2	2	2			0
	Lower Devil's Canyon	0	0	0		0	0	0			0
	Upper Queen Creek	0	0	0		1	1	1			0
	Lower Queen Creek	0	0	0	0	0	0	0			0
	Mineral Creek	0	0		0	0	0	0			0
Fluoride		**4 T**		**140 T**	**140 T**						
	Upper Devil's Canyon	0		0							
	Middle Devil's Canyon	0		0							
	Lower Devil's Canyon	0		0							
	Upper Queen Creek	0		0							
	Lower Queen Creek	0		0	0						
	Mineral Creek	0			0						
Iron							**1 D**				
	Upper Devil's Canyon						2				
	Middle Devil's Canyon						0				
	Lower Devil's Canyon						0				
	Upper Queen Creek						0				
	Lower Queen Creek						0				
	Mineral Creek						0				
Lead		**0.015 T**		**0.015 T**	**0.015 T**						**0.100 T**
	Upper Devil's Canyon	0		0		0	36				0
	Middle Devil's Canyon	0		0		0	21				0
	Lower Devil's Canyon	0		0		0	57				0
	Upper Queen Creek	1		1		0	3		0	3	0
	Lower Queen Creek	2		2	2	0	4				1
	Mineral Creek	1			1	0	0				1
Manganese*		**0.98**		**130.667**							
	Upper Devil's Canyon	2		0							

		Number of Exceedances by Major Stream System, for Arizona Surface Water Quality Standards									
PARAMETER	Stream System	DWS	FC	PBC	FBC	A&Ww Acute	A&Ww Chronic	A&We Acute	A&W edw Acute	A&W edw Chronic	AgL
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
	Middle Devil's Canyon	0		0							
	Lower Devil's Canyon	0		0							
	Upper Queen Creek	1		0							
	Lower Queen Creek	1		0							
	Mineral Creek	1		0							
Mercury		**0.002 T**		**0.280 T**	**0.280 T**	**0.0024 D**	**0.00001 D**	**0.005 D**			**0.010 T**
	Upper Devil's Canyon	0		0		0	29	0			0
	Middle Devil's Canyon	0		0		0	27	0			0
	Lower Devil's Canyon	0		0		0	9	0			0
	Upper Queen Creek	0		0		0	20	0			0
	Lower Queen Creek	0		0	0	0	6	0			0
	Mineral Creek	0		0	0	0	6	0			0
Nickel		**0.210 T**	**0.511 T**	**28.000 T**	**28.000 T**						
	Upper Devil's Canyon	0	0	0		0	5				
	Middle Devil's Canyon	0	0	0		0	0				
	Lower Devil's Canyon	0	0	0		0	2				
	Upper Queen Creek	0	0	0		0	0		0	0	
	Lower Queen Creek	0	0	0	0	0	1				
	Mineral Creek	0	0	0	0	0	0				
Nitrate*		**10 T**		**3,733.333**							
	Upper Devil's Canyon	0		0							
	Middle Devil's Canyon	0		0							
	Lower Devil's Canyon	0		0							
	Upper Queen Creek	0		0							
	Lower Queen Creek	0		0							
	Mineral Creek	0		0							
Nitrite*		**1 T**		**233.333**							
	Upper Devil's Canyon	1		0							
	Middle Devil's Canyon	1		0							
	Lower Devil's Canyon	0		0							
	Upper Queen Creek	0		0							
	Lower Queen Creek	0		0							
	Mineral Creek	0		0							
Nitrate + Nitrite		**10 T**									
	Upper Devil's Canyon	0									
	Middle Devil's Canyon	0									

		Number of Exceedances by Major Stream System, for Arizona Surface Water Quality Standards									
PARAMETER	**Stream System**	**DWS**	**FC**	**PBC**	**FBC**	**A&Ww Acute**	**A&Ww Chronic**	**A&We Acute**	**A&W edw Acute**	**A&W edw Chronic**	**AgL**
		mg/L	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
	Lower Devil's Canyon	0									
	Upper Queen Creek	0									
	Lower Queen Creek	0									
	Mineral Creek	0									
Radium 226 + Radium 228		**5 pCi/L**									
	Upper Devil's Canyon	0									
	Middle Devil's Canyon	0									
	Lower Devil's Canyon	0									
	Upper Queen Creek	0									
	Lower Queen Creek	0									
	Mineral Creek	0									
Selenium		**0.050 T**	**0.667 T**	**4.667 T**	**4.667 T**		**0.002 T**	**0.033 T**			**0.050 T**
	Upper Devil's Canyon	0	0	0	0		26	0			0
	Middle Devil's Canyon	0	0	0	0		21	0			0
	Lower Devil's Canyon	0	0	0	0		7	0			0
	Upper Queen Creek	0	0	0	0		17	0			0
	Lower Queen Creek	0	0	0	0		1	0			0
	Mineral Creek	0	0	0	0		4	0			0
Silver		**0.035 T**	**8.000 T**	**4.667 T**	**4.667 T**						
	Upper Devil's Canyon	0	0	0	0	18					
	Middle Devil's Canyon	0	0	0	0	1					
	Lower Devil's Canyon	0	0	0	0	13					
	Upper Queen Creek	0	0	0	0	0					
	Lower Queen Creek	0	0	0	0	1					
	Mineral Creek	0	0	0	0	0					
Thallium		**0.002 T**	**0.001 T**	**0.075 T**	**0.075 T**	**0.700 D**	**0.150 D**		**0.700 D**	**0.150 D**	
	Upper Devil's Canyon	21	38	0	0	0	0		0	0	
	Middle Devil's Canyon	17	34	0	0	0	0		0	0	
	Lower Devil's Canyon	7	9	0	0	0	0		0	0	
	Upper Queen Creek	12	34	0	0	0	0		0	0	
	Lower Queen Creek	1	7	0	0	0	0		0	0	
	Mineral Creek	1	27	0	0	0	0		0	0	
Uranium		**0.030 D**		**2.8 T**	**2.8 T**						
	Upper Devil's Canyon	0		0	0						
	Middle Devil's Canyon	0		0	0						
	Lower Devil's Canyon	0		0	0						

PARAMETER	Stream System	DWS	FC	PBC	FBC	A&Ww Acute	A&Ww Chronic	A&We Acute	A&W edw Acute	A&W edw Chronic	AgL
		Number of Exceedances by Major Stream System, for Arizona Surface Water Quality Standards									
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
	Upper Queen Creek	0		0	0						
	Lower Queen Creek	0		0	0						
	Mineral Creek	0		0	0						
Zinc		**2.100 T**	**5.106 T**	**28.0000 T**	**28.0000 T**						**25.000 T**
	Upper Devil's Canyon	0	0	0	0	0	0				0
	Middle Devil's Canyon	0	0	0	0	0	0				0
	Lower Devil's Canyon	0	0	0	0	0	0				0
	Upper Queen Creek	0	0	0	0	0	0		0	0	0
	Lower Queen Creek	0	0	0	0	0	0				0
	Mineral Creek	0	0	0	0	0	0				0
E. coli†			**235 cfu/100 ml**	**575 cfu/100 ml**							
	Upper Devil's Canyon		3	3							
	Middle Devil's Canyon		1	1							
	Lower Devil's Canyon		0	0							
	Upper Queen Creek		1	1							
	Lower Queen Creek		0	0							
	Mineral Creek		0	0							

Note: A&We = aquatic and wildlife ephemeral warm water; A&W edw = aquatic and wildlife (effluent-dependent waters); A&Ww = aquatic and wildlife warm water resource; AgL = agricultural livestock watering; DWS = drinking water standard; FBC = full body contact; FC = fish consumption; ND = no data; PBC = partial body contact;
Units: cfu/100 ml = colony-forming units per 100 milliliters; D = dissolved; mg/L = milligrams per liter; pCi/l = picocuries per liter; T = total
* Water quality standards based on dissolved concentrations, but nitrate, nitrite, and manganese exceedances determined based on total concentrations as that was all that was available.
† E. coli data as reported are in units inconsistent with standards

The analyses in section 3.7.2 rely on Arizona surface water and aquifer water quality standards as a comparison to provide context to modeled water quality results. Standards vary by use and in some cases, by hardness. For reference, table N-5 summarizes all numeric surface water and groundwater quality standards (Arizona Administrative Code, R18-11 Article 1), and which standards are applicable to the water bodies of interest.

Table N-5. Summary of numeric Arizona surface water and aquifer quality standards

	A&Ww Chronic	A&Ww Acute	A&We	FBC	PBC	FC	AgI	AgL	Surface Water Standard for Most Restrictive Use (Queen Creek)	Surface Water Standard for Most Restrictive Use (Gila River at Donnelly Wash)	Surface Water Standard for Most Restrictive Use (Gila River at Dripping Spring Wash)	Surface Water Standard for Most Restrictive Use (Ephemeral Tributaries)	Aquifer Water Quality Standard
Gila River	X	X		X		X	X	X					
Queen Creek	X	X		X		X		X					
Donnelly Wash, Potts Canyon, Roblas Canyon, Silver King Wash, Dripping Spring Wash			X		X								
Constituents with Numeric Standards													
Antimony	0.030	0.088	-	0.747	0.747	0.640	-	-	0.030	0.030	0.030	0.747	0.006

	A&Ww Chronic	A&Ww Acute	A&We	FBC	PBC	FC	AgI	AgL	Surface Water Standard for Most Restrictive Use (Queen Creek)	Surface Water Standard for Most Restrictive Use (Gila River at Donnelly Wash)	Surface Water Standard for Most Restrictive Use (Gila River at Dripping Spring Wash)	Surface Water Standard for Most Restrictive Use (Ephemeral Tributaries)	Aquifer Water Quality Standard
Arsenic	0.150	0.340	0.440	0.030	0.280	0.080	2	0.2	0.030	0.030	0.030	0.280	0.05
Barium	-	-	-	98	98	-	-	-	98	98	98	98	2
Beryllium	0.0053	0.065	-	1.867	1.867	0.084	-	-	0.0053	0.0053	00053	1.867	0.004
Boron	-	-	-	186.667	186.667	-	1	-	1	1	1	186.667	-
Cadmium*	-	-	-	0.7	0.7	0.084	0.05	0.05	0.0051	0.0049	0.0043	0.2175	0.005
- At hardness = 242 mg/L	0.0043	0.0111	0.1681	-	-	-	-	-	-	-	-	-	-
- At hardness = 290 mg/L	0.0049	0.0135	0.2045	-	-	-	-	-	-	-	-	-	-
- At hardness = 307 mg/L	0.0051	0.0144	0.2175	-	-	-	-	-	-	-	-	-	-
- At hardness = 400 mg/L	0.0062	0.0191	0.2895	-	-	-	-	-	-	-	-	-	-
Chromium, Total	-	-	-	-	-	-	1	1	1	1	1	-	0.1
Copper*	-	-	-	1.3	1.3	-	5	0.5	0.0234	0.0222	0.0191	0.0669	-
- At hardness = 242 mg/L	0.0191	0.0308	0.0535	-	-	-	-	-	-	-	-	-	-
- At hardness = 290 mg/L	0.0222	0.0366	0.0634	-	-	-	-	-	-	-	-	-	-
- At hardness = 307 mg/L	0.0234	0.0386	0.0669	-	-	-	-	-	-	-	-	-	-
- At hardness = 400 mg/L	0.0293	0.0495	0.0859	-	-	-	-	-	-	-	-	-	-
Fluoride	-	-	-	140	140	-	-	-	140	140	140	140	4
Iron	1	-	-	-	-	-	-	-	1	1	1	-	-
Lead*	-	-	-	0.015	0.015	-	10	0.1	0.0083	0.0078	0.0065	0.015	0.05
- At hardness = 242 mg/L	0.0065	0.1665	0.3514	-	-	-	-	-	-	-	-	-	-
- At hardness = 290 mg/L	0.0078	0.2013	0.4248	-	-	-	-	-	-	-	-	-	-
- At hardness = 307 mg/L	0.0083	0.2136	0.4508	-	-	-	-	-	-	-	-	-	-
- At hardness = 400 mg/L	0.0109	0.2808	0.5926	-	-	-	-	-	-	-	-	-	-
Manganese	-	-	-	130.667	130.667	-	10	-	10	10	10	130.667	-
Mercury	0.0024	0.00001	0.005	0.28	0.28	-	-	0.010	0.00001	0.00001	0.00001	0.005	0.002
Nickel*	-	-	-	28	28	4.6	-	-	0.1343	0.1280	0.1098	10.7379	0.1
- At hardness = 242 mg/L	0.1098	0.9887	8.7803	-	-	-	-	-	-	-	-	-	-
- At hardness = 290 mg/L	0.1280	1.1523	10.2327	-	-	-	-	-	-	-	-	-	-
- At hardness = 307 mg/L	0.1343	1.2092	10.7379	-	-	-	-	-	-	-	-	-	-
- At hardness = 400 mg/L	0.1680	1.5126	13.4319	-	-	-	-	-	-	-	-	-	-
Nitrate	-	-	-	3,733.333	3,733.333	-	-	-	3,733.333	3,733.333	3,733.333	3,733.333	10
Nitrite	-	-	-	233.333	233.333	-	-	-	233.333	233.333	233.333	233.333	1
Selenium	0.002	-	0.033	4.667	4.667	0.667	0.020	0.050	0.002	0.002	0.002	0.033	0.05
Silver*	-	-	-	4.667	4.667	8	-	-	0.0221	0.0201	0.0147	0.0221	-
- At hardness = 242 mg/L	-	0.0147	0.0147	-	-	-	-	-	-	-	-	-	-
- At hardness = 290 mg/L	-	0.0201	0.0201	-	-	-	-	-	-	-	-	-	-
- At hardness = 307 mg/L	-	0.0221	0.0221	-	-	-	-	-	-	-	-	-	-
- At hardness = 400 mg/L	-	0.0349	0.0349	-	-	-	-	-	-	-	-	-	-

	A&Ww Chronic	A&Ww Acute	A&We	FBC	PBC	FC	AgI	AgL	Surface Water Standard for Most Restrictive Use (Queen Creek)	Surface Water Standard for Most Restrictive Use (Gila River at Donnelly Wash)	Surface Water Standard for Most Restrictive Use (Gila River at Dripping Spring Wash)	Surface Water Standard for Most Restrictive Use (Ephemeral Tributaries)	Aquifer Water Quality Standard
Thallium	0.15	0.7	-	0.075	0.075	0.0072	-	-	0.0072	0.0072	0.0072	0.075	0.002
Uranium	-	-	-	2.8	2.8	-	-	-	2.8	2.8	2.8	2.8	-
Zinc*	-	-	-	280	280	5.106	10	25	0.3031	0.2888	0.2477	2.8758	-
- At hardness = 242 mg/L	0.2477	0.2477	2.3508	-	-	-	-	-	-	-	-	-	-
- At hardness = 290 mg/L	0.2888	0.2888	2.7403	-	-	-	-	-	-	-	-	-	-
- At hardness = 307 mg/L	0.3031	0.3031	2.8758	-	-	-	-	-	-	-	-	-	-
- At hardness = 400 mg/L	0.3792	0.3792	3.5985	-	-	-	-	-	-	-	-	-	-
pH	6.5–9.0	6.5–9.0	6.5–9.0	6.5–9.0	6.5–9.0	-	4.5–9.0	6.5–9.0	6.5–9.0	6.5–9.0	6.5–9.0	6.5–9.0	-
Constituents without Numeric Standards													
Sulfate	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Dissolved Solids	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

Notes: A&Ww = Aquatic and Wildlife-Warmwater; A&We = Aquatic & Wildlife-Ephemeral; FBC = Full Body Contact; PBC = Partial Body Contact; FC = Fish Consumption; AgI = Agricultural-Irrigation; AgL = Agricultural-Livestock Watering

Standards for A&Ww and A&We are for dissolved concentrations, except for selenium which is for total concentrations. All other standards are for total concentrations.

All values shown in milligrams per liter.

* These constituents have surface water standards that vary depending on hardness, with a maximum hardness of 400 mg/L. The four hardness values shown were chosen as follows:

- 242 mg/L represents the hardness for the Gila River at Dripping Spring Wash, based on a sample collected November 19, 2018, calculated from a calcium concentration of 64.8 mg/L and a magnesium concentration of 19.4 mg/L. This hardness was used for ephemeral tributaries as well.
- 290 mg/L represents the hardness for the Gila River at Donnelly Wash, based on a sample collected November 13, 2018, calculated from a calcium concentration of 77.7 mg/L and a magnesium concentration of 23.4 mg/L
- 307 mg/L represents the hardness for Queen Creek at Whitlow Ranch Dam, based on the lowest calculated hardness from five samples (August 25, 2017), calculated from a calcium concentration of 87.5 mg/L and a magnesium concentration of 21.4 mg/L
- 400 mg/L represents the maximum hardness that can be used to calculate surface water standards. Many of the geochemical samples (synthetic precipitate leaching procedure [SPLP] results, for instance) exceed this hardness.

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APPENDIX O. DRAFT PROGRAMMATIC AGREEMENT REGARDING COMPLIANCE WITH THE NHPA ON THE RESOLUTION COPPER PROJECT AND SOUTHEAST ARIZONA LAND EXCHANGE

PROGRAMMATIC AGREEMENT
AMONG THE
USDA FOREST SERVICE TONTO NATIONAL FOREST,
ARIZONA STATE HISTORIC PRESERVATION OFFICER,
THE ADVISORY COUNCIL ON HISTORIC PRESERVATION,
REGARDING
COMPLIANCE WITH THE NATIONAL HISTORIC PRESERVATION ACT
ON THE RESOLUTION COPPER PROJECT
AND SOUTHEAST ARIZONA LAND EXCHANGE
NEAR SUPERIOR, ARIZONA

1. WHEREAS, Resolution Copper Mining, LLC (Resolution Copper), proposes to conduct mining operations on land administered by the U.S. Department of Agriculture (USDA) Forest Service (Forest Service) Tonto National Forest (TNF), land administered by the Arizona State Land Department (ASLD), and private land near Superior, Pinal County, Arizona, based on a General Plan of Operations (GPO); and

2. WHEREAS, the GPO details Resolution Copper's proposed mining operations as consisting of five locations: East Plant Site, West Plant Site, Tailings Facility and Tailings Corridor, Magma Arizona Railroad Company (MARRCO) corridor, and Filter Plant and Loadout Facility, with the five locations presented in the GPO estimated to disturb a total of 6,951 acres of TNF, ASLD, and private land within a 13,713-acre project area; and

3. WHEREAS, the GPO includes the mining and processing (concentrator and filter plant/rail loadout) operations, transportation corridors for conveying concentrate and tailings, utility corridors, and a tailings facility; and

4. WHEREAS, TNF and Resolution Copper have developed alternatives for comparative analysis and compliance with the National Environmental Policy Act (NEPA, 42 United States Code [U.S.C.] 4321 et seq.) that may include transportation and utility corridors, tailings storage facilities, and a Filter Plant and Loadout Facility on U.S. Department of the Interior Bureau of Land Management (BLM) Tucson Field Office, TNF, ASLD, and private lands; and

5. WHEREAS, on December 12, 2014, Congress passed the Southeast Arizona Land Exchange and Conservation Act (Section 3003 of Public Law 113-291), which authorizes a land exchange between the U.S. government (U.S. Department of Agriculture and U.S. Department of the Interior) and Resolution Copper. Under the exchange, Resolution Copper will receive 2,422 acres of land known as the Oak Flat Federal Parcel (Selected Lands) managed by the Forest Service in exchange for 5,376 acres of private land (Offered Lands) owned by Resolution Copper consisting of eight parcels: Apache Leap South End Parcel (142 acres) near Superior in Pinal County; Tangle Creek Parcel (148 acres) in Yavapai County; Turkey Creek Parcel (147 acres) in Gila County; Cave Creek parcel (149 acres) near Cave Creek in Maricopa County; East Clear Creek Parcel (640 acres) near Payson in Coconino County; Lower San Pedro River Parcel (3,050 acres) near Mammoth in Pinal County; Appleton Ranch Parcel (940 acres) near Elgin in Santa Cruz County; and Dripping Springs Parcel (160 acres) near Kearny in Gila and Pinal Counties; and

6. WHEREAS, both the land exchange mandated by the Southeast Arizona Land Exchange and Conservation Act and the approval of the GPO submitted by Resolution Copper constitute a Federal undertaking (Undertaking) as defined by 36 Code of Federal Regulations (CFR) 800.16(y) which requires compliance with Section 106 of the National Historic Preservation Act (NHPA); and

7. WHEREAS, the TNF is the lead agency for the Section 106 compliance process; and

8. WHEREAS, the TNF has consulted with the Arizona State Historic Preservation Officer (SHPO) pursuant to 36 CFR 800.6 regarding the resolution of adverse effects and SHPO is a Signatory to this Programmatic Agreement (Agreement); and

9. WHEREAS, the BLM Tucson Field Office is considering issuing Federal authorizations related to the mitigation, construction, operation, maintenance, and reclamation of portions of the proposed Undertaking that must comply with Section 106 of the NHPA and applicable portions of the Archaeological Resources Protection Act (ARPA; 16 U.S.C. 470aa–470mm), the American Indian Religious Freedom Act (42 U.S.C. 1996), and the Native American Graves Protection and Repatriation Act (NAGPRA; 25 U.S.C. 3001 et seq.), and the BLM is participating as an Invited Signatory to this Agreement; and

10. WHEREAS, the Arizona State Museum (ASM) has been invited to participate because it has mandated authority and responsibilities under the Arizona Antiquities Act, Arizona Revised Statutes (ARS) 41-841 et seq., that apply to that portion of the Undertaking on State land, and mandated authority and responsibilities under ARS 41-865 that apply to that portion of the Undertaking on private land; and

11. WHEREAS, any testing and data recovery necessitated by the Undertaking, located on State land, must be permitted by the ASM pursuant to ARS 41-842, and ASM is an Invited Signatory to this Agreement; and

12. WHEREAS, the U.S. Army Corps of Engineers (USACE) may be responsible for issuing a Clean Water Act Section 404 permit for the Undertaking, and recognizes the TNF as the lead Federal agency, and is an Invited Signatory to this Agreement under 36 CFR 8002(a)(2) to act on its behalf under Section 106, and

13. WHEREAS, the Undertaking includes State Trust land administered by the ASLD, and the ASLD may use provisions of this Agreement to address the applicable requirements of the Arizona State Historic Preservation Act (ARS 41-861 et seq.) on State land in Arizona, and the ASLD is an Invited Signatory to this Agreement; and

14. WHEREAS, Resolution Copper, as an applicant and consulting party, is entitled to participate in the Section 106 consultation process under 36 CFR 800.2(c)(4) and in the development of this Agreement per 36 CFR 800.6(a)(2), because of its obligations and duties to implement the mitigation measures as required under both the Southeast Arizona Land Exchange Act (Sec. 3003) and the Agreement, and is an Invited Signatory under 36 CFR 800.6(c)(2)(iii); and

15. WHEREAS, the TNF has assumed the lead Federal agency status for government-to-government consultation with Indian Tribes, and has the delegated authority of the Secretary of Agriculture to implement the Southeast Arizona Land Exchange including the mandate to "*consult with Resolution Copper and seek to find mutually acceptable measures to—(i) address the concerns of the affected Indian tribes; and (ii) minimize the adverse effects on the affected Indian tribes resulting from mining and related activities on the Federal land conveyed to Resolution Copper under this section.* (Sec. 3003(c)(3))"; and

16. WHEREAS, during project initiation in 2008, the Forest Service initiated consultation with the Tribes they regularly consult—the Fort McDowell Yavapai Nation, the Gila River Indian Community, the Hopi Tribe, the Mescalero Apache Tribe, the Pueblo of Zuni, the Salt River Pima-Maricopa Indian

Community, the San Carlos Apache Tribe, the Tonto Apache Tribe, the White Mountain Apache Tribe, the Yavapai-Apache Nation, and the Yavapai Prescott Indian Tribe; and

17. WHEREAS, additional locations have been proposed for the permanent disposal and management of the mine tailings, including the alternative on BLM land, and BLM routinely consults with four additional Tribes—the Ak-Chin Indian Community, the Fort Sill Apache Tribe, the Pascua Yaqui Tribe, and the Tohono O′odham Nation—that may also have traditional and/or cultural interests within the expanded environmental impact statement (EIS) analysis area; and

18. WHEREAS, the TNF has invited all 15 Tribes to participate as concurring parties in this Agreement, and additional Tribes may be added and/or removed at their request as the consultation progresses and as the project scope and area of potential effects (APE) are finalized; and

19. WHEREAS, TNF has determined due to the scale and complexity of the Undertaking that it will develop a Programmatic Agreement, pursuant to 36 CFR 800.14(b)(1), to address further identification requirements and resolution of adverse effects; and

20. WHEREAS, in accordance with 36 CFR 800.6(a)(1), the TNF notified the Advisory Council on Historic Preservation (ACHP) of its adverse effect finding, provided the specified documentation, and invited the ACHP to participate in consultation (using the ACHP's e-file notification system on December 7, 2017), and the ACHP has chosen to participate in this Agreement (letter dated December 21, 2017); and

21. WHEREAS, the proposed action and all alternatives encompasses 40,988 acres and multiple land jurisdictions as shown on figure 1 in Appendix A, and consists of the Selected Lands leaving the jurisdiction of the Federal Government (2,422 acres) per Section 3003 of Public Law 113-291, and the project components and all alternatives associated with the Resolution Copper GPO (38,566 acres not including those also within the land exchange); and

22. WHEREAS, the direct APE for ground disturbance will consist of the Oak Flat Federal Parcel and the GPO with the selected tailings alternative; and

23. WHEREAS, the indirect APE consists of a 2-mile buffer around the direct APE and its alternatives with multiple land jurisdictions as shown on figure A.1 in Appendix A; and

24. WHEREAS, the atmospheric APE including visual and auditory effects and the cumulative APE together consist of a 6-mile buffer around the direct APE and its alternatives with multiple land jurisdictions as shown on figure A.1 in Appendix A; and

25. WHEREAS, this project is located within the adjudicated territory of the Salt and Gila River Tribes; however, this landscape is important to many tribes and has been for many generations. It continues to this day to be utilized for cultural and spiritual purposes.

26. WHEREAS, the Forest has consulted regularly with eleven federally-recognized tribes that are culturally affiliated with the lands that stand to be affected. Tribes have had the opportunity to be active in the consultation, review and comment processes of the project. No tribe supports the desecration/destruction of ancestral sites. Places where ancestors have lived are considered alive and sacred. It is a tribal cultural imperative that these places should not be disturbed for any reason. Continued access to the land and all its resources is necessary and should be accommodated for present and future generations. Participation in the design of this destructive activity has caused considerable emotional stress and brings direct harm to the traditional way of life to tribes; however, it is still deemed necessary

to ensure ancestral homes and ancestors receive the most thoughtful and respectful treatment possible. These eleven tribes represent four cultural groups with ties to the traditional homelands: Akimel O'Odham (Gila River Indian Community, Salt River Pima-Maricopa Indian Community), Puebloan (Hopi Tribe, Pueblo of Zuni), Apache (Mescalero Apache Tribe, San Carlos Apache Tribe, Tonto Apache Tribe, White Mountain Apache Tribe, Yavapai-Apache Nation), and Yavapai (Fort McDowell Yavapai Nation, Yavapai Apache Nation, Yavapai Prescott Indian Tribe. Consultation has identified two distinct culturally-affiliated treatments of Native American human remains and cultural items, based on whether they are prehistoric or protohistoric/historic in age. These two distinctions will determine specific treatment protocols for ancestral sites and remains.

27. WHEREAS, 721 archaeological sites (both prehistoric and historic), one traditional cultural property (TCPs), and 11 places of traditional religious and cultural significance have been identified to date within the direct APE, with surveys ongoing (see figures in Appendix B for identified historic properties and previous survey report references); and

28. WHEREAS, the TNF, in consultation with the SHPO, has determined that 523 archaeological sites are eligible for the National Register of Historic Places (NRHP) under Criterion D, as well as one TCP that has been listed in the NRHP under Criteria A, B, C, and/or D; and

29. WHEREAS, additional inventory efforts needed to completely identify cultural resources within the direct, atmospheric, and indirect APEs will likely add additional NRHP-eligible historic properties, and TNF will continue to seek concurrence on its determinations of eligibility and effect from the SHPO as further cultural resource inventories are completed for the remainder of the project; and

30. WHEREAS, for portions of the direct APE that have not already been surveyed for cultural resources, the TNF proposes to phase any remaining identification and evaluation needs, pursuant to 36 CFR 188.4(b)(2), I, and complete all inventory in the summer of 2019; and

31. WHEREAS, because 118 archaeological sites in the APE shown in Appendix B are currently unevaluated for listing on the NRHP, and additional cultural resources may be identified as surveys continue; and

32. WHEREAS, the TNF has determined that the Undertaking will result in adverse effects to historic properties including TCPs that have been determined eligible for the NRHP under Criteria A, B, C, and/or D, and has consulted with the SHPO, pursuant to 36 CFR 800, regarding the regulations implementing Section 106 of the NHPA. Adverse effects include, but are not limited to, transfer of historic properties out of federal ownership, physical destruction and/or damage due to ground disturbance, and changes to setting; and

33. WHEREAS, the SHPO is authorized to enter into this Agreement in its role of advising and assisting Federal agencies in carrying out their Federal responsibilities under Sections 101 and 106 of the NHPA, at 36 CFR 800.2(c)(l)(i) and 36 CFR 800.6(b), and to fulfill its state historic preservation responsibilities under ARS 41-511.04(D)(4); and

34. WHEREAS, the TNF is committed to respecting the sensitive and private nature of tribal traditional knowledge; and,

35. WHEREAS, a comprehensive ethnographic and ethnohistoric study regarding places of traditional or cultural importance to Indian Tribes was completed (Hopkins et al. 2015) and the Forest Service has implanted a tribal monitoring program to identify historic properties in the APE; and

36. WHEREAS, the Tribes have stated that the APE is within a landscape important to many Tribes and has been for many generations, and continues to this day to be utilized for cultural and spiritual purposes; no Tribe supports the desecration/destruction of ancestral sites because places where ancestors have lived are considered alive and sacred, it is a tribal cultural imperative that these places should not be disturbed for any reason, and continued access to the land and all its resources is necessary and should be accommodated for present and future generations; participation in the design of this destructive activity has caused considerable emotional stress and brings direct harm to the traditional way of life to Tribes; however, it is still deemed necessary to ensure ancestral homes and ancestors receive the most thoughtful and respectful treatment possible; and

37. WHEREAS, the Tribes have declared that they consider adverse effects from the Undertaking to be unmitigable and, even if they sign this Agreement, they consider the mitigation in the document as being insufficient; and

38. WHEREAS, the TNF has used and coordinated the NEPA public participation requirements to assist the Federal agencies in satisfying the public involvement requirements under Section 106 pursuant to 36 CFR 800.2(d)(3) through involving interested parties in the NEPA process, providing project information to the public, giving them opportunities to comment on the project through public scoping and alternatives meetings, and will continue to disseminate information through public meetings and will afford the public opportunities to comment on the EIS throughout the drafting process; and

39. WHEREAS, the Signatories, Invited Signatories, and concurring parties of this Agreement will be referred to as Consulting Parties in this Agreement; and

40. WHEREAS, the TNF, in consultation with all Consulting Parties, will explore both traditional and alternative mitigation measures that are in the public interest and provide the best use of available funding and resources as it seeks to resolve adverse effects to historic properties; and

41. WHEREAS, definitions used in this Agreement are outlined in Appendix C of this document; and

NOW THEREFORE, the TNF, SHPO, and the ACHP agree that this Agreement shall be implemented in accordance with the following stipulations to address the effects of the Undertaking on historic properties.

STIPULATIONS

The TNF shall ensure that the following stipulations are carried out:

I. ROLES AND RESPONSIBILITIES

A. TONTO NATIONAL FOREST

1. The signatories agree that the TNF is the lead Federal agency for administering and implementing this Agreement with responsibilities that include:
    - consulting and coordinating with the Consulting Parties;
    - carrying out their responsibilities in accordance with applicable laws and authorities ensuring that all Signatories and Invited Signatories fulfill their obligations;
    - making Determinations of NRHP eligibility and Determinations of Effect for cultural resources on TNF land;
    - overseeing all cultural resource management work in coordination with appropriate land-managing agencies including any additional historic properties inventory, and drafting and/or assembling all submissions to the Consulting Parties, including the additional historic properties inventory reports (if needed), historic property treatment plans (HPTPs), and the preliminary and final data recovery reports;
    - seeking SHPO concurrence with agency decisions as required by 36 CFR 800 relating to the treatment of historic properties; and
    - implementing the HPTP(s).
2. The TNF will use the principles in the Forest Service policy, *Consultation with Indian Tribes and Alaska Native Corporations* (Forest Service Manual 1563.1) to guide its tribal consultation procedures and relationships. The TNF shall, in compliance with Section 3003(c)(3) of the Southeast Arizona Land Exchange Act, engage as the lead agency for the following:
    a. government-to-government consultation with affected Indian Tribes concerning issues of concern to the affected Indian Tribes related to the land exchange.
    b. consultations with Resolution Copper to find mutually acceptable measures that: (i) address the concerns of the affected Indian Tribes; and (ii) minimize the adverse effects on properties significant to Indian Tribes resulting from mining and related activities on the Federal land conveyed to Resolution Copper.

B. RESOLUTION COPPER MINING, LLC

1. Per the Carl Levin and Howard P. 'Buck' McKeon National Defense Authorization Act for Fiscal Year 2015 (NDAA 2015) § 3003, the signatories agree that Resolution Copper "shall agree to pay, without compensation, all costs that are associated with the land exchange and any environmental review document." As part of the environmental review process, Resolution Copper is financially responsible for all work that is associated with complying with the NHPA and Arizona State Historic Preservation Act (ARS 41-861 et seq. and ARS 41-865).
    a. This includes, but is not limited to: inventories of archaeological sites, historic buildings and structures, and TCPs within the APE; evaluation of all cultural resources for inclusion in the NRHP; determination of the effects of the Undertaking on historic properties in consultation with the SHPO and Consulting Parties; and creation and implementation of the HPTPs and any mitigation measures (i.e., data recovery) for the

historic properties within the APE as agreed to by the signatories to this Agreement through the consultation process.

C. BUREAU OF LAND MANAGEMENT

1. For the purposes of the Undertaking, the BLM shall work in coordination with TNF for both agencies to comply with Section 106 of the NHPA. The BLM retains authority for the management of all resources and historic properties on BLM lands (Alternative 5). The BLM will participate only in those activities related to its jurisdiction or decision-making authorities, unless otherwise invited by the TNF. The BLM's status as a Cooperating Agency and Invited Signatory to this Agreement does not affect its independent responsibilities under applicable Federal statutes and regulations that may pertain to the agency's special expertise and/or jurisdictional authorities.
2. If an alternative that does not involve BLM-administered land becomes the selected alternative, the BLM's responsibilities and involvement in this Agreement shall cease.

D. U.S. ARMY CORPS OF ENGINEERS

1. For purposes of this undertaking, USACE shall work in coordination with TNF to comply with Section 106 of the NHPA. USACE will only participate in those activities within their defined permit area related to Clean Water Act Section 404 permitting per 33 CFR Part 325 Appendix C (1)(g). This also extends to compensatory mitigation activities, yet to be specifically defined, that may be required of the Permittee, Resolution Copper.
2. If an alternative that does not require a Section 404 permit becomes the selected alternative, USACE's responsibilities and involvement in this Agreement shall cease.

E. ARIZONA STATE LAND DEPARTMENT

1. ASLD, in coordination with the TNF and the SHPO, will be responsible for reviewing all cultural resources work completed on State Trust land, including inventories, determinations of eligibility and effect, HPTPs, and the preliminary and final data recovery reports. ASLD shall work in close coordination with TNF to complete the Section 106 process and ensure compliance with the Arizona State Historic Preservation Act (ARS 41-861 et seq.). The ASLD shall retain responsibility for the management of cultural resources that are located on ASLD land. ASLD will participate only in those activities in those areas related to its jurisdiction or decision-making authorities, unless otherwise invited by the TNF.

F. ARIZONA STATE MUSEUM

1. ASM will be responsible for reviewing proposed and completed archaeological work in accordance with ARS 41-841 et seq., Rules Implementing ARS 15-1631 and 41-841 et seq., ARS 41-865, Rules Implementing ARS 41-865, and ASM policy and procedures.

II. PROFESSIONAL QUALIFICATIONS AND PERMITS

A. For all cultural resource-related activities, Resolution Copper shall ensure that its cultural resources contractors use qualified historic preservation professionals that meet the Secretary of the Interior's standards (48 Federal Register 44716), as per Section 112(a)(1)(A) of the NHPA and 36 CFR 800.2(a)(1).

B. For cultural resource-related activities on Federal land, Forest Service and/or BLM shall ensure that all agency personnel responsible for historic properties shall meet Professional Qualification Standards as defined by the Office of Personnel Management: Heritage Program Professionals (GS-170 historian, GS-190 anthropologist, and GS-193 archaeologist; see definition in Appendix C). For work on Forest Service land, only Heritage Program Professionals may make management recommendations and review and recommend approval of heritage work done by Forest Service employees, contractors, and volunteers. For work on BLM land, only BLM-designated Heritage Program Specialists make recommendations and review and recommend approval of heritage work done by BLM employees, contractors, and volunteers.

C. For cultural resource-related activities on Federal land, the Forest Service and/or the BLM shall ensure that all necessary permits and permissions are obtained from the appropriate land-managing agency prior to any fieldwork, including ARPA permits for any ground-disturbing work.

D. For all cultural resource-related activities occurring on State land, Resolution Copper shall ensure that its cultural resources contractors obtain an Arizona Antiquities Act Permit from the ASM prior to conducting archaeological activities on State land pursuant to ARS 41-841 et seq. Resolution Copper shall also ensure that its cultural resources contractors obtain a burial agreement from the ASM prior to all ground-disturbing activity on State and private lands pursuant to Rules Implementing ARS 41-844 and 41-865.

E. In recognition of the special expertise of tribal experts concerning properties of traditional religious and/or cultural significance, the standards of 36 CFR 61 will not apply to tribally designated representatives carrying out identification and evaluation efforts for such properties of tribal interest.

III. COORDINATION WITH OTHER FEDERAL REVIEWS

A. Any Federal agency that will provide approvals or assistance for the Undertaking may comply with the agency's Section 106 responsibilities by agreeing to the terms of this Agreement in writing and sending copies of such written agreement to all the parties of this Agreement.

B. In the event that another Federal agency not initially a party to or subject to this Agreement receives an application for funding/license/permit for the Undertaking as described in this Agreement, that agency may fulfill its Section 106 responsibilities by stating in writing it concurs with the terms of this Agreement and notifying TNF, the SHPO, and the ACHP that it intends to do so. In the event that an above Federal agency's application for funding/license/permit does not match the undertaking as described in this Agreement, that agency may complete a separate review to fulfill its Section 106 responsibilities or request of the signatories that the Agreement be amended to account for those changes in the undertaking.

IV. AREA OF POTENTIAL EFFECTS

A. **Direct effects**: The APE for direct effects will include the Selected Lands leaving Federal management under the land exchange and the project areas associated with the GPO. The APE for direct effects during construction, operations, and reclamation and will include all areas likely to be affected by such activities, as well as the Selected Lands (see Appendix A). The direct effects APE associated with the GPO will be modified as necessary to allow for adjustments in construction, operations, and access road placement to avoid, when possible, natural, cultural, or modern features such as outcrops, historic properties, petroglyph sites, and structures. The final acreage and layout of the APE will be dependent on which alternative is selected (see Appendix A).

Indirect effects: The APE for indirect effects shall be areas within 2 miles from any project component (including any access routes, facilities, and relocated facilities) or where consultation identifies a need to expand this APE in certain locations (see Appendix A).

Atmospheric effects: The APE for atmospheric effects (including visual and auditory) shall be areas within 6 miles from any project component (including any access routes, facilities, and relocated facilities) or the visual horizon, whichever is closer, or where consultation identifies a need to expand this APE in certain locations (see Appendix A).

The APEs may extend beyond the above definitions to encompass properties that have traditional religious and cultural importance, including TCPs or other geographically extensive historic properties such as trails, when effects have been determined through consultation with the SHPO and Consulting Parties to extend beyond this distance.

B. **Cumulative effects**: The APE for cumulative effects shall be the same as that for the direct, atmospheric, and indirect effects combined.

C. The Forest Service shall ensure that any modification of the APE will be done through consultation conducted among the Consulting Parties. The Forest Service shall notify the Signatories to the Agreement of any proposed modifications. Signatories, Invited Signatories, and Consulting Parties shall have 14 calendar days to respond to the proposed changes; if no response is received, the Forest Service will make a good-faith effort to contact the Signatories and, if no response is received, will proceed with the modifications. Modifications to the APE will not require an amendment to the Agreement.

V. TRIBAL CONSULTATION

A. Through government-to-government consultation with Indian Tribes, pursuant to 36 CFR 800.2(c)(2), TNF and other Federal land-managing agencies, as appropriate, have made and will continue to make a good-faith effort to identify properties that have traditional religious and cultural significance to one or more Indian Tribes and to determine whether they are NRHP-eligible historic properties. Tribal comments and concerns will be consolidated for consideration by the respective land-managing agency. All parties to this Agreement will respect any sites of traditional religious and cultural importance (NHPA 101(d)(6)(A)) and confidentiality concerns expressed by Indian Tribes to the extent allowed by law (see Stipulation XIV). The Signatories shall follow the regulations outlined in 36 CFR 800 Subpart B.

B. In compliance with Chapter 10, Consultation with Indian Tribes and Alaska Native Corporations of the Forest Service Handbook titled *American Indian and Alaska Native Relations Handbook* (FSH 1509.13), the TNF will continue to engage Indian Tribes in government-to-government consultation throughout the duration of the Undertaking through in-person meetings, telephone calls, and on-site field visits. Information and documents will be provided via mail, email, or in person.

C. In general, the TNF Forest Supervisor and Tribal Liaison at a minimum, often accompanied by Forest Service subject experts, offer to travel at least once per year to each Tribe culturally affiliated with TNF land to provide updates on ongoing or proposed projects within the TNF. Additional meetings with the associated cultural groups (Apache, Akimel O'odham, Puebloan, and Yavapai) are scheduled. At least once per year the Forest Service hosts an All Tribes Meeting to discuss the larger actions in this project (for example the Tribal Monitor Program, the HPTP, and this Agreement). The Forest Service consistently consults with Tribes while documents are in draft form and before they are finalized. Consultation with Tribes has repeatedly resulted in activities design (and redesign), document design (and redesign), field visits, and the creation of projects and programs. Examples of actions include sensitive plant monitoring for the magnetotelluric study at Oak Flat, Oak Flat listing to the NRHP, the Superior Area Ethnographic Study, activity component relocation to protect TCPs in the GPO, custom design of the Apache Leap Special Management Area, the identification of alternate mine tailings locations away from TCPs, the creation of the Tribal Monitor Program, archaeological site restoration with Tribes at Oak Flat, and the Emory Oak Restoration Program. Consultation will continue as needed throughout the lifetime of this project.

VI. IDENTIFICATION OF HISTORIC PROPERTIES

A. TNF shall ensure all of the Selected Lands, GPO project areas, and alternatives are surveyed for cultural resources prior to the Record of Decision as directed by Section 3003 of Public Law 113-291. Cultural resources inventory surveys conducted to date are shown in Appendix B. Separate inventories are being conducted with tribal monitors and/or tribal elder consultation to identify cultural resources significant to tribal peoples and TCPs within the Selected Lands, GPO project areas, and alternatives, in addition to the archaeological and historic building/structure inventory.

B. Surveys to date cover the portions of the APE that include the Oak Flat Federal Parcel, GPO project components (East Plant Site, West Plant Site, MARRCO Corridor, and Filter and Loadout Facility), and the proposed tailings locations for Alternatives 2, 3, 4, and 5. Additional survey is in progress for the Alternative 6 tailings location, pipeline routes for Alternatives 5 and 6, main 230-kilovolt power lines for the GPO and power line route for Alternative 6, and any remaining areas not covered in earlier surveys due to project adjustments, and is scheduled to be completed in the summer of 2019.

C. Identification of cultural resources has yet to be completed for the Skunk Camp Tailings location (Alternative 6), pipeline routes for Alternatives 5 and 6, main 230-kilovolt power lines for the GPO and power line route for Alternative 6, and any remaining areas not covered in earlier surveys due to project adjustments. Surveys of Alternative 6 and the pipeline/access routes to Alternatives 5 and 6 will be overseen by the Forest Service and will be completed in the summer of 2019.

D. If additional areas are identified that need cultural resources inventories due to necessary changes in the GPO after the signing of this Agreement, the TNF shall ensure that all inventories will be carried out in conformance with current professional standards and will consist of a 100% survey strategy.

E. The completed historic property inventories have included inventories for TCPs and places of traditional or cultural significance to Indian Tribes through a tribal monitoring program. Trained tribal monitors have worked both with the archaeological survey crews and independently to record places of traditional or cultural significance and identify those that would qualify as TCPs under Section 106 of the NHPA. Additional inventories, such as that for Skunk Camp, will include tribal monitor surveys for TCPs and places of traditional or cultural significance and will be supervised by the Forest Service. Due to the sensitive nature of these surveys, they will be reported on separately from the archaeological findings.

F. Per Federal and State guidelines, the draft inventory report(s) generated through this identification effort will be reviewed and revised in three steps:

1. The draft inventory report(s) will be first reviewed by both the TNF and the other appropriate land-managing agency (BLM or ASLD) for a 30-day comment and review period. Comments will then be incorporated into a revised draft report.
2. Once accepted by the agency's cultural resource specialist, the revised draft inventory reports and associated documentation will be submitted to all Consulting Parties for a 30-day review and comment period. The TNF will also submit the TNF's determinations of eligibility and effects to the SHPO along with revised draft report for a 30-day review and comment period.
3. The TNF will consider all comments received during this period, and a draft final inventory report will be produced that will be submitted to the Consulting Parties for a 30-day review period.

   If the TNF does not receive a response from a Consulting Party during these review periods, the TNF will make a good-faith effort to contact the party by email and telephone. If, after a reasonable and good-faith effort to reach an unresponsive party, there is no response, the TNF will proceed to the next step prescribed by this Agreement (Stipulation VIII).

G. A Class I literature review of the 6-mile atmospheric APE for historic properties listed in or eligible for the NRHP under Criteria A, B, and/or C (properties where impacts to setting could alter the characteristics that make the property eligible for the NRHP) was completed in October 2018. No ground disturbance is planned outside the direct APE; therefore, properties eligible under Criterion D were not included. The search included records at the Forest Service, BLM, and on the AZSITE online database and identified 14 historic buildings, structures, or districts listed in the NRHP and 37 archaeological sites eligible for the NRHP.

H. A Class I literature review for the indirect APE will be conducted to identify historic properties which may be indirectly affected by the Undertaking. The Class I review will include archaeological sites, historic buildings and structures, historic districts, and TCPs. Information will be sought through records searches and consultation.

I. The Forest Service shall ensure that a single report will be prepared, detailing the results of both the Class I for the atmospheric APE and the Class I for the indirect APE. The report shall include contextual information, property types, and an overview of the effects of the Undertaking. The draft Class I report will be reviewed as set forth in the above Stipulation VI.F.

VII. TRIBAL MONITOR PROGRAM

In consultation with Indian Tribes, the request was heard by the Forest to employ "Tribal Monitors," to conduct pedestrian survey alongside archaeologists. Tribal Monitors function as traditional cultural specialists who have the ability to identify important resources on the landscape that are both archaeological and non-archaeological. Incorporating tribal members into data-gathering processes maximizes transparency and cooperation between the Forest Service and participating Tribes. In their own words, the Tribal Monitors consider themselves the "eyes and ears" of their communities. The TNF Tribal Monitor Program places an emphasis on providing the opportunity for tribal elders, traditional practitioners, and tribal leaders to visit locations identified by the monitors. Monitors working directly with traditional practitioners helps to ensure sites are being identified correctly and concerns are being discussed and recorded for the report. The Tribal Monitor reports will be reviewed by the agency decision maker to ensure tribal concerns are being considered. The program currently consists of 30 monitors; in response to tribal requests, a third training is scheduled for the summer of 2019.

VIII. EVALUATION OF HISTORIC PROPERTIES

A. The historic properties identified as of June 6, 2019, are listed in Appendix B. In total, 721 archeological sites have been recorded within the Oak Flat Federal Parcel, GPO project components, and the proposed tailings location for Alternatives 2, 3, 4, and 5. Of these, 523 sites have been determined eligible for the NRHP, and 86 sites have been determined not eligible for the NRHP. Another 118 sites are unevaluated against NRHP significance criteria. Two sites are exempt from Section 106 consultation because they are in-use gas pipelines, per the ACHP's *Exemption Regarding Historic Preservation Review Process for Projects Involving Natural Gas Pipelines* (Federal Register, Vol. 67, No. 66, April 5, 2002).

B. TNF shall ensure all cultural resources identified during additional Class III inventory and through tribal consultation will be evaluated by the TNF for their eligibility for the NRHP and for project effects in accordance with 36 CFR 800.4(b) and in consultation with the appropriate Consulting Parties. The TNF shall make determinations of eligibility and effect upon completion of all inventory reports in coordination with land-managing agencies when appropriate; the SHPO shall be afforded the opportunity to review and concur on the determinations (see Stipulation VI).

C. If the NRHP eligibility of cultural resources cannot be determined at the time of initial inventory, the TNF will either (a) ensure that an eligibility testing program is conducted according to the provisions outlined in Stipulation IX below, or (b) treat unevaluated cultural resources as eligible for the NRHP. The TNF's subsequent NRHP determinations in concurrence with the land-managing agency when appropriate will then be submitted to the SHPO for concurrence in accordance with 36 CFR 800.4(b)(2).

D. Should the SHPO disagree with these determinations, the TNF will try to resolve the disagreement informally. If after a reasonable and good-faith effort a resolution cannot be achieved, the TNF shall request a formal determination from the Keeper of the National Register if it is an issue of determination of eligibility, per 36 CFR 63. For disputes regarding determinations of effects, mitigation, or other parts of the Section 106 process other than NRHP-eligibility determinations, the TNF shall request that the ACHP resolve the dispute, per 36 CFR 800.2(b)(2).

E. The TNF has determined that the Undertaking will have an adverse effect on historic properties; however, the TNF, in consultation with the appropriate land-managing agency, will determine on a property-by-property basis if the Undertaking will have an adverse effect on specific historic properties in the GPO with the exception of those in the Oak Flat Federal Parcel. Because the Oak Flat Federal Parcel will be leaving Federal ownership, the Undertaking will have an adverse effect on all historic properties within the parcel.

F. Visual effects to historic properties in the atmospheric APE, and the potential impacts to setting for qualifying historic properties, will be assessed using viewshed modeling of the visibility of project components and factoring qualities such as distance from the project component, intervening landforms and/or human-made constructions, and overall modifications to the visual landscape.

G. If the TNF does not receive a response from a Consulting Party during these review periods, the TNF will make a good-faith effort to contact the party by email and telephone. If, after a reasonable and good-faith effort to reach an unresponsive party, there is no response, the TNF will proceed to the next step prescribed by this Agreement as described in Stipulation IX.

IX. MITIGATION AND TREATMENT PLANS

A. Because of the size and complexity of the Undertaking, mitigation resolution of adverse effects to historic properties will be outlined in several documents.

1. The TNF will prepare an archaeological HPTP with support from Resolution Copper for the Oak Flat Federal Parcel (Selected Lands) prior to the land exchange and the execution of the Agreement. Implementation of this HPTP will begin prior to the land exchange and may still be ongoing after the formal transfer of the Oak Flat Federal Parcel.
2. Separate from the Oak Flat Federal Parcel HPTP, the TNF will prepare, with support from Resolution Copper, an overall archaeological Research Design for the GPO, including the selected tailings alternative in place of a GPO HPTP prior to the execution of the Agreement. Detailed Data Recovery Plans for each GPO component will then be prepared under the GPO Research Design after the Agreement is executed. It is anticipated that treatments and mitigations for the GPO will be implemented after the formal transfer of the Oak Flat Federal Parcel.
3. The TNF will prepare a separate and confidential Mitigation Plan describing the steps needed for the mitigation of the adverse effects to TCPs affected by the Undertaking. Mitigation negotiations are ongoing and because of the sensitive and sacred nature of the resources to Tribes, these negotiations are confidential.
4. If needed, the TNF will prepare additional mitigation plan(s) that describe mitigation measures to address atmospheric (including visual), indirect, and cumulative effects to historic properties, TCPs, and the cultural and natural resources important to the Tribes.

B. Preparation of the Oak Flat HPTP and GPO Research Design with Data Recovery Plans:

1. The Research Design for the GPO will consist of a context and research design that will apply to all areas of the GPO and alternatives. Data Recovery Plans for detailing the plan of work for each GPO project component area will be prepared under the umbrella document of the GPO Research Design.
2. If Alternative 5 (Peg Leg) is selected, the Data Recovery Plan for the tailings alternative area and associated infrastructure will be prepared in direct coordination with the BLM and submitted to SHPO and the Tribes for review and comment.
3. Mitigation in the Oak Flat Federal Parcel HPTP and GPO Data Recovery Plans will include, but is not limited to, data recovery for historic properties that are eligible for the NRHP under Criterion D.
4. The data recovery strategy specified in the Oak Flat Federal Parcel HPTP and the GPO Research Design in conjunction with the Data Recovery Plans will be consistent with the *Secretary of the Interior's Standards and Guidelines* (48 Federal Register 44716-44742), the ACHP's *Recommended Approach for Consultation on Recovery of Significant Information from Archeological Sites* (64 Federal Register 95:27085–27087), and guidance from the TNF and SHPO.
5. The archaeological strategies specified in the HPTP and the GPO Research Design will be consistent with ARS 41-841 et seq. and ARS 41-865 for work conducted on State and private lands, respectively.
6. The Oak Flat Federal Parcel HPTP and the GPO Research Design in conjunction with the Data Recovery Plans will specify at a minimum:

a. The results of previous research and a research design that discusses the questions to be addressed through data recovery, archival research, analysis and interpretation, with an explanation of their relevance and importance;

b. The process for interfacing the results of eligibility testing and the resultant determinations of eligibility with the relevant data recovery methodology;

c. The results of tribal consultation regarding the incorporation of tribal perspectives into the culture history, research design, data recovery methods, analysis, and interpretation;

d. The properties or portions of properties where data recovery is to be carried out, and any property or portion of property that would be affected by the Undertaking without treatment, and a rationale for dealing with affected properties or portions (e.g., discussion of the sampling strategy, avoidance, etc.);

e. If the data recovery is to be phased (i.e., additional data recovery is required), a discussion of the transition between Phase I and Phase II including time frames for review of preliminary reports and field visits/consultations;

f. The archival, field, and laboratory methods to be used, with an explanation of their relevance to the research questions;

g. Specification of the methods and level of effort to be expended on the treatment of each historic property;

h. The methods to be used in the management and dissemination of the resultant data to the professional community and the public as outlined below in Stipulation IXF, including a proposed schedule for tasks outlined in the GPO, and a schedule for the submittal of draft and final reports (Summary Treatment Report(s) and Full Treatment Report(s)) to Consulting Parties for review and comment;

i. A discussion of permits and personnel qualifications for archaeological crews;

j. A provision for cultural and archaeological sensitivity training for construction personnel, and an outline of topics to be covered in sensitivity trainings, including tribal participation, if possible, in leading the trainings;

k. The proposed disposition and curation of recovered materials and records in accordance with relevant state and Federal laws (36 CFR 79).

C. The Forest Service shall develop a TCP Redress Plan which shall include at a minimum:

1. Tribal perspectives of the Undertaking footprint and the surrounding vicinity;

2. The tribal consultation steps taken by the TNF and results of that consultation including the types of TCPs located in the Undertaking footprint;

3. A discussion of the tribal monitoring program, field methods, and results;

4. A discussion of and commitment to the sensitivity and privacy regarding tribal knowledge, including how sensitive information will not be released to the public, how all public documents will be redacted or written so that sensitive information will not be needed; and how all exchanges of sensitive information to and from the Forest Service will be kept internally;

5. A description of the TCPs in the APE for direct, atmospheric, and indirect effects; however, the TNF will be sensitive to the private nature of tribal knowledge for this section;

6. A description of all mitigation to be conducted to resolve adverse effects to TCPs. Please note that negotiations between the Tribes, the TNF, and Resolution Copper are ongoing. Because the adverse effects of the Undertaking are to a sacred resource, all parties involved in the negotiations have agreed to keep the details confidential;

7. A description of tribal monitoring to be conducted during the construction of mining facilities on Federal, State, and private lands.

D. The Forest Service shall implement a burial plan that corresponds to the requirements of each landholding jurisdiction: a NAGPRA Plan of Action for Federal lands; and an ASM Burial Agreement for state and private lands in accordance with Stipulation XI, and included as an appendix in all documents discussing Section 106 compliance.

E. The Forest Service shall prepare a separate Monitoring and Discovery Plan prior to the land exchange and the issuance of a Notice to Proceed from the Forest Service for the GPO with procedures for monitoring, evaluating, and treating discoveries of unexpected or newly identified nonhuman remains and cultural resources during implementation of the Undertaking, including the consultation process and timelines with appropriate Consulting Parties.

1. If historic properties will be avoided by activities associated with the Undertaking on Federal or State land, but could be threatened after construction by operations, maintenance, and/or decommissioning of the Undertaking, the Monitoring and Discovery Plan will include a program for long-term monitoring of these historic properties on Federal or State land.
2. The Monitoring and Discovery Plan will also include tribal monitoring during construction of mining facilities on private, State, and Federal lands. All discussion of tribal monitoring and resources shall be in a form suitable for public viewing (i.e., for construction and mining personnel).

F. The Forest Service shall develop a strategy for a public education program per ACHP guidelines presented in *Recommended Approach for Consultation on Recovery of Significant Information from Archeological Sites* (June 17, 1999) with the goal of disseminating information to the general public about the results (either ongoing or post-data recovery) of the historic properties investigations, completed in coordination with the Tribes and Consulting Parties. This program shall include at a minimum: presentation of data recovery results at a local archaeological conference and a display for Arizona Archaeology Awareness Month activities.

G. Section 106 Mitigation Documents Review

1. Upon receipt of a draft of the documents, the TNF will submit the draft to the SHPO and simultaneously afford all Consulting Parties to this Agreement the opportunity to review and comment. All parties will have 30 calendar days from receipt to review and provide comments to the TNF.
2. If revisions to the documents are needed, all Consulting Parties to this Agreement will have 30 calendar days from receipt to review and comment on the revisions.
3. The TNF will ensure that an in-person meeting is scheduled with the Tribes to discuss their comments, if requested.
4. If the TNF does not receive a response from a Consulting Party during these review periods, the TNF will make a good-faith effort to contact the party by email and telephone. If, after a reasonable and good-faith effort to reach an unresponsive party, there is no response, the TNF assumes there are no comments.
5. Copies of the final documents in electronic and hard copy format will be provided by the TNF to all Consulting Parties to this Agreement.

H. HPTP and GPO Data Recovery Plans Implementation

1. The land-managing agencies will only authorize the proposed archaeological fieldwork or other mitigation strategies after the TNF has approved the HPTP and GPO Data Recovery Plans and the SHPO has concurred.
2. If in-field modifications of the HPTP or GPO Data Recovery Plans are necessary, the TNF shall consult with the appropriate land-managing agency and the SHPO prior to approving the modification. Once the TNF has notified the SHPO of the changes, the SHPO shall have 14 days to comment. Comments will then be addressed by the TNF; if no comments are received within 14 days, the TNF will move forward. Modifications will be discussed and justified in the report(s) of the work.

I. Summary Treatment Report(s)

1. The TNF shall ensure that Summary Treatment Reports summarizing the implementation of the Oak Flat Federal Parcel HPTP and GPO Data Recovery Plans or other treatments are prepared within 30 calendar days after fieldwork or other mitigation strategies are completed. Separate reports may be prepared for archaeological work and non-archaeological mitigation.
2. The Summary Treatment Report for archaeological work will contain at a minimum:
   a. Descriptions and justifications of any changes in field methods from those presented in the HPTP or Data Recovery Plans.
   b. A map of each treated site showing excavated areas, feature locations, areas monitored, and other data as appropriate.
   c. A list of features identified at each site, brief descriptions, extent of investigation, and assessment of function and age.
   d. A summary of the data recovery results, including summary descriptions of recovered artifacts and samples, by class.
   e. A discussion of any suggested changes or refinements to the research questions or analyses identified in the research design that might be warranted based on the preliminary findings and the character of the recovered assemblages.
   f. A schedule for the completion of all analyses and submission of the Full Treatment Report.
3. Summary Treatment Reports for all other mitigation strategies (non-archaeological) will include:
   a. A description of the work conducted in accordance with the treatment plans.
   b. Any deviations from the plans with justifications.
   c. Results of work conducted.
4. The TNF shall submit the draft Summary Treatment Report to the SHPO and simultaneously afford all Consulting Parties to this Agreement the opportunity to review and comment on the report(s) within 20 calendar days of receipt of the report. The TNF will consult with the SHPO and other Consulting Parties to this Agreement to ensure, to the extent the TNF agrees, that any comments are addressed in the final Summary Treatment Report. If any party fails to respond in writing, by telephone, or by email within 20 calendar days, it is assumed that there are no comments.

J. Full Treatment Report(s)

1. Draft Full Treatment Reports will be prepared for each treated project component.

2. The TNF shall ensure that Draft Full Treatment Reports are completed within 1 year of completion of applicable fieldwork, and Final Reports within 2 years of completion of applicable fieldwork or mitigation tasks.
3. The Draft and Full Treatment Report(s) will contain at a minimum:
    a. Discussion of the methods and treatments applied to the historic properties with an assessment of the degree to which these methods and treatments followed the direction provided by the plans and comments to the Summary Treatment Report.
    b. Discussion of any changes in methods from those proposed in the plans.
    c. A topographic plan view map for each treated historic property investigated, depicting all features, treatment areas, and other data as appropriate.
    d. Final descriptions, drawings, and/or photographs for each feature.
    e. Final descriptions and analyses of all recovered data classes.
    f. Final interpretation of each site according to the research contexts identified in the plans.
    g. Overall synthesis of the data recovery and analysis results with an interpretation of perceived patterns.
    h. Interpretation of the project results in a regional context.
    i. If a burial agreement with the ASM has been acquired, all information relevant to compliance with the reporting requirements under the burial agreement.
    j. A schedule for the completion of all curation and repatriation requirements.
4. The TNF will provide the Draft Full Treatment Reports to the SHPO and simultaneously afford all Consulting Parties to this Agreement the opportunity to review and comment on the report(s). SHPO and the other Consulting Parties to this Agreement will have 30 calendar days from receipt of the Draft Full Treatment Report to review and comment.
5. If the TNF does not receive a response from a Consulting Party during these review periods, the TNF will make a good-faith effort to contact the party by email and telephone. If, after a reasonable and good-faith effort to reach an unresponsive party, there is no response, it is assumed there are no comments.
6. TNF will direct Resolution Copper in the completion of the Full Treatment Report to address all comments. Electronic and hard copies of the Full Treatment Report will be provided to TNF and in turn to the SHPO, land-management agencies, and other Consulting Parties to this Agreement. Land-management agencies are responsible for filing this documentation with the curation repository for their collections.

K. Because the treatments may be long term, progress on treatments to mitigate adverse effects will be reported on during the annual report required by this Agreement per Stipulation XVII. A separate stand-alone treatment report for TCPs will not be prepared.

X. OTHER COMPENSATIONS

If during the life of the mine, other compensations not discussed in Stipulation IX are needed to address adverse effects to cultural resources, the Forest Service shall ensure that those compensations are developed and implemented in consultation with the Tribes. The Forest Service shall ensure that tribal concerns are addressed and redressed throughout the life of the project.

XI. TREATMENT OF HUMAN REMAINS AND FUNERARY OBJECTS

Human remains, associated funerary objects, sacred objects, objects of cultural patrimony, objects of tribal patrimony, or formal non-human burials discovered on Federal land will be treated in compliance with NAGPRA, ARPA, and the Forest Service Region 3 policy for the treatment and disposition of Native American human remains and associated funerary objects recovered from Forest Service Southwestern Region lands (Region 3 Supplement 2300-99-3 to Forest Service Manual, Chapter 2360 – Special Interest Areas, Section 2361.29–Recovery, Curation and Public Use, 08/12/1999).

A NAGPRA Plan of Action regarding the treatment and disposition of any human remains, funerary objects, sacred objects, objects of cultural patrimony, objects of tribal patrimony, or formal non-human burials discovered on Federal land will be developed by the TNF or the BLM, according to each agency's jurisdictional authority (see Appendix D).

Human remains, funerary objects, sacred objects, objects of cultural patrimony, objects of tribal patrimony, or formal non-human burials discovered on State land will be treated in compliance with ARS 41-844, and human remains and funerary objects discovered on private land will be treated in compliance with ARS 41-865 under the jurisdictional authority of the Director of the ASM. For cultural resources work on State or private land, a burial agreement for the treatment and disposition of human remains, funerary objects, sacred objects, objects of cultural patrimony, objects of tribal patrimony, or formal non-human burials must be developed in coordination with ASM.

XII. AUTHORIZATION OF PROJECT ACTIVITY IMPLEMENTATION

A. For activities on Forest Service land, ground-disturbing/GPO activities may be authorized once the TNF, in consultation with the SHPO pursuant to Stipulations VI through VIII, determines that:

    1. No historic properties are present within the Undertaking APE at the location of the proposed activity; or

    2. Historic properties that are present within the APE at the location of the proposed activity will not be adversely affected; or

    3. The HPTP has been implemented for historic properties that are present within the APE at the location of a proposed activity that will be adversely affected, and the Summary Treatment Report documenting compliance with the HPTP has been accepted by the TNF with the understanding that a full report is in preparation. TNF may only authorize activities if such authorization will not preclude the ability to redesign or relocate project activities to avoid adverse effects on historic properties, or to resolve those adverse effects in accordance with the terms of this Agreement.

B. For activities on BLM land, ground-disturbing/GPO activities may be authorized once the TNF and BLM, in consultation with the SHPO, pursuant to Stipulations VI through VIII, determine that:

    1. No historic properties are present within the Undertaking APE at the location of the proposed activity; or

    2. Historic properties that are present within the APE at the location of the proposed activity will not be adversely affected; or

    3. The HPTP has been implemented for historic properties that are present within the APE at the location of a proposed activity that will be adversely affected, and the Summary Treatment Report documenting compliance with the HPTP has been accepted by the TNF and the BLM with the understanding that a full report is in preparation.

C. For activities on ASLD land, ground-disturbing/GPO activities may be authorized once the TNF and ASLD, in consultation with the SHPO pursuant to Stipulations VI through VIII, determine that:

1. No historic properties are present within the Undertaking APE at the location of the proposed activity; or
2. Historic properties that are present within the APE at the location of the proposed activity will not be adversely affected; or
3. The HPTP has been implemented for historic properties that are present within the APE at the location of a proposed activity and will be adversely affected, and the Summary Treatment Report documenting compliance with the HPTP has been accepted by the TNF and the ASLD with the understanding that a full report is in preparation.

D. For activities located on non-federal lands within the USACE's permit area associated with a Section 404 permit, ground-disturbing/GPO activities may be authorized once the TNF, in consultation with the SHPO pursuant to Stipulations VI through VIII, determines that:

1. No historic properties are present within the Undertaking APE at the location of the proposed activity; or
2. Historic properties that are present within the APE at the location of the proposed activity will not be adversely affected; or
3. The HPTP has been implemented for historic properties that are present within the APE at the location of a proposed activity that will be adversely affected, and the Summary Treatment Report documenting compliance with the HPTP has been accepted by the TNF with the understanding that a full report is in preparation.

XIII. COMMUNICATION AMONG PARTIES TO THE PROGRAMMATIC AGREEMENT

Electronic mail (email) will serve as the preferred official correspondence for all communications regarding this Agreement and its provisions. See Appendix E for a list of contacts and email addresses. Contact information in Appendix E may be updated as needed without an amendment to this Agreement. It is the responsibility of each Consulting Party to immediately inform the TNF of any change in name, email address, or telephone number for any point-of-contact. The TNF will forward this information to all Consulting Parties by email.

XIV. CONFIDENTIALITY

To the maximum extent allowed by Federal and state law, the TNF will maintain confidentiality of sensitive information regarding historic properties that could be damaged through looting or disturbance, and/or to help protect a historic property to which a Tribe attaches religious or cultural significance. However, any documents or records the TNF has in its possession are subject to the Freedom of Information Act (FOIA) (5 U.S.C. 552 et seq.) and its exemptions, as applicable. The TNF shall evaluate whether a FOIA request for records or documents would involve a sensitive historic property, or a historic property to which a Tribe attaches religious or cultural significance, and if such documents contain information that the TNF is authorized to withhold from disclosure by other statutes including Section 304 of the NHPA, and the provisions of the ARPA. If this is the case, TNF will consult with the Keeper of the Register and the ACHP regarding withholding the sensitive information per 36 CFR 800.11(c). If a tribally sensitive property is involved, the TNF will also consult with the relevant Tribe prior to making a determination in response to a FOIA request.

XV. EMERGENCIES

Should an emergency situation occur that represents an immediate threat to life or property, the TNF shall immediately notify the SHPO, Tribes, and land managers (as applicable) as to the situation and the measures taken to respond to the emergency or hazardous condition. Should land managers or Tribes desire to provide technical assistance to the TNF, they shall submit comments within 7 calendar days from notification, if the nature of the emergency or hazardous condition allows for such coordination.

XVI. CURATION

The TNF shall ensure that all records and materials resulting from compliance with Section 106 for the Undertaking are curated at a repository approved by the TNF or participating land-managing agency, and that the facility meets the standards set forth in the 1980 ACHP Handbook and the 1990 Guidelines for 36 CFR 79. In compliance with the Arizona Antiquities Act, the TNF will ensure that all materials recovered from State land and the associated reports will be curated at ASM or another approved repository. Curation costs will be the responsibility of Resolution Copper.

XVII. ANNUAL REVIEW OF PROGRAMMATIC AGREEMENT AND ANNUAL REPORT

A. The Consulting Parties shall evaluate the implementation and operation of this Agreement on an annual basis. There shall be an annual meeting among the Consulting Parties on or near the anniversary date of the execution of this Agreement to review the progress and effectiveness of this Agreement. The TNF is responsible for setting up this meeting, in coordination with all the Consulting Parties.

B. Prior to the annual meeting, the TNF will provide Consulting Parties with an annual report (Annual Report) to review the progress under this Agreement and under the approved HPTP(s). The Annual Report will include:

   1. acreage of new historic property/cultural resources surveys and results;
   2. status of mitigation activities;
   3. monitoring efforts;
   4. unanticipated discoveries,
   5. ongoing and completed public education activities;
   6. any issues that are affecting or may affect the ability of the Federal agencies to continue to meet the terms of this Agreement;
   7. any disputes and objections received, and how they were resolved;
   8. any additional parties who have become signatories or concurring parties to this Agreement in the past year; and
   9. proposed plans for next year’s activities.

C. Consulting Parties will have 30 calendar days to review the Annual Report and provide comments to the TNF, which will then consolidate the comments to develop the agenda for the annual meeting.

D. Within 14 calendar days after the annual meeting, the TNF will summarize the meeting, including proposed action items and how they are to be addressed, in a letter to Consulting Parties. After the meeting, Consulting Parties will have 20 calendar days to review and comment on the meeting notes and, if necessary, provide the TNF with any edits to the meeting notes. If changes are needed, the TNF will produce revised meeting notes within 30 calendar days of receipt of comments and will provide the final notes to the Consulting Parties.

E. Evaluation of the implementation of this Agreement may also include in-person meetings or conference calls among Consulting Parties, and suggestions for possible modifications or amendments to this Agreement. If the TNF does not receive a response from a Consulting Party, the TNF will make a good-faith effort to contact the party by email and telephone. If, after a reasonable and good-faith effort to reach an unresponsive party, there is no response, the TNF will proceed to the next step.

XVIII. POST-REVIEW DISCOVERIES OF CULTURAL RESOURCES

A. The TNF will ensure that procedures regarding post-review discoveries are included as provisions of Resolution Copper's GPO. The protocol to be followed will also be identified in the Monitoring and Discovery Plan.

B. The TNF will ensure that Resolution Copper immediately halts ground-disturbing activities within a 100-foot-radius of any new discovery of cultural resources, clearly marks the area of discovery, takes steps to ensure that the area is protected and secured, implements additional measures, as appropriate, to protect the discovery from looting and vandalism, and has a professional archaeologist inspect the area and vicinity to determine the extent of the discovery and provide recommendations to TNF regarding NRHP eligibility, effect, and mitigation treatment.

C. The TNF will notify the SHPO, affiliated Tribes, and applicable land managers, within 48 hours of the discovery, and will provide its assessment of the NRHP eligibility of the discovery and measures proposed to resolve adverse effects. The TNF will take into account the SHPO's, Tribes', and applicable land manager's recommendations on eligibility and treatment of the discovery, as tiered off of the Oak Flat Federal Parcel HPTP or the GPO Research Design, and will notify Resolution Copper of any appropriate actions required to resolve adverse effects.

D. If the post-review discovery consists of human remains or funerary objects, the TNF shall follow the procedures outlined in the NAGPRA Plan of Action for discoveries on Federal land or those outlined in the burial plan for discoveries on State or private land per ARS 41-844 and ARS 41-865 (see Stipulation XI). In addition, humans remains and funerary objects shall be treated in accordance with Stipulation XI.

E. The TNF, in coordination with any applicable land manager, may allow construction activities to proceed in the area of discovery after the TNF has determined that implementation of the actions taken to address the discovery pursuant to this Stipulation have been completed.

XIX. AMENDMENTS

A. This Agreement may be amended when such an amendment is agreed to in writing by all Signatories and Invited Signatories. Any Signatory or Invited Signatory may propose an amendment in writing to the TNF. The amendment will be effective on the date a copy signed by all of the Signatories is filed with the ACHP.

B. Copies of the amendment will be provided by the TNF to all parties to this Agreement.

XX. DISPUTE RESOLUTION

Should any signatory or concurring party to this Agreement object at any time to any actions proposed or the manner in which the terms of this Agreement are implemented, the TNF shall consult with such party to resolve the objection and shall notify the SHPO and Consulting Parties of the objection. If the TNF determines that such objection cannot be resolved, the TNF will:

A. Forward all documentation relevant to the dispute, including the TNF's proposed resolution, to the ACHP. The ACHP shall provide the TNF with its opinion on the resolution of the objection within 30 calendar days of receiving adequate documentation. Prior to reaching a final decision on the dispute, the TNF shall prepare a written response that takes into account any timely opinion or comments regarding the dispute from the ACHP, signatories, and concurring parties, and provide them with a copy of this written response. The TNF will then proceed according to its final decision.

B. If the ACHP does not provide comments regarding the dispute within the 30-day time period, the TNF may make a final decision on the dispute and proceed accordingly. Prior to reaching a final decision, the TNF shall prepare a written response that takes into account any timely comments regarding the dispute from the signatories and concurring parties to the Agreement and provide them and the ACHP with a copy of such written response.

C. The responsibilities of the TNF to carry out all other actions subject to the terms of this Agreement that are not the subject of the dispute remain unchanged.

XXI. TERMINATION

A. If any signatory to this Agreement determines that its terms will not or cannot be carried out, the TNF shall immediately consult with the other signatories to attempt to develop an amendment per Stipulation XIX. If, within 30 calendar days (or another time period agreed to by all signatories), an amendment cannot be reached, any signatory may terminate this Agreement upon written notification to the other signatories.

B. Once this Agreement is terminated, and prior to work continuing on the Undertaking, the TNF must either (a) execute an Agreement pursuant to 36 CFR 800.6, or (b) request, take into account, and respond to the comments of the ACHP under 36 CFR 800.7. The TNF shall notify the signatories as to the course of action it will pursue.

C. At any point after the execution of this Agreement, and after providing written notice to the Signatories and Invited Signatories, the BLM or the USACE may (a) determine that it no longer has Section 106 responsibilities associated with the Undertaking; or (b) decide to continue complying with its Section 106 responsibilities independently through a separate Agreement per 36 CFR 800.14(b) or, failing that, (c) through its request, consideration, and response to the formal comments of the ACHP per 36 CFR 800.7(c), determine that it will no longer participate in this Agreement. Such a decision by the BLM or USACE will not affect this Agreement with regard to other land managers and/or permitting entities who are Signatories and/or Invited Signatories and will not require an amendment to this Agreement.

D. If the project is suspended or terminated for any reason, in-process mitigation will be completed according to the appropriate plan to the extent applicable. This includes data recovery and mitigation of adverse effects to TCPs. Resolution Copper will be responsible for the costs associated with completion of the mitigation. For data recovery, the Forest Service shall ensure that any in-process data recovery fieldwork is completed and that all analysis, interpretation, reporting, curation of artifacts, and repatriation of remains be completed within 1 year of project suspension or termination. For other mitigation, the Forest Service shall, in consultation with the land-managing agencies, SHPO, and Tribes, develop steps for completion of the mitigation within 1 year of the suspension or termination.

XXII. TRANSFER OF PERMITS TO SUCCESSOR

Any transfer or assignment of the Agreement for the Undertaking to another party will require the assignee or successor to assume all responsibilities of Resolution Copper under this Agreement for mitigation of adverse effects, and any successor or assignee of Resolution Copper is bound to the terms of this Agreement. Any transfer or assignment of the permits for the Undertaking to another party will require the assignee or successor to sign an amendment to this Agreement to become an Invited Signatory at the time of transfer or assignment. All Consulting Parties will be notified if an amendment to reassign the duties of Resolution Copper is proposed.

XXIII. DURATION OF PROGRAMMATIC AGREEMENT

This Agreement shall be in effect for 10 years with the understanding that it will be extended after 10 years. The Forest Service will ensure that an agreement is in place for the duration of the mine.

XXIV. ANTI-DEFICIENCY ACT

The TNF’s obligations under this Agreement are subject to availability of appropriated funds, and the stipulations of this Agreement are subject to the provisions of the Anti-Deficiency Act. The TNF shall make reasonable and good-faith efforts to secure the necessary funds to implement this Agreement in its entirety. If compliance with the Anti-Deficiency Act alters or impairs the TNF’s ability to implement the stipulations of this agreement, the TNF shall consult in accordance with the amendment and termination procedures found at Stipulations XIX and XXI of this Agreement.

XXV. NON-ENDORSEMENT CLAUSE

Nothing in this Agreement should be interpreted to imply that any party endorses the Undertaking. Consulting Parties will not take any action or make any statement that suggests or implies such an endorsement based on signing this Agreement. Per 36 CFR 800.6(c)(2)(iv), the refusal of any party invited to become a signatory or concurring party will not invalidate this Agreement.

XXVI. AUTHORIZING SIGNATURES

In witness hereof, the following authorized representatives of the parties have signed their names on the dates indicated, thereby executing this Agreement. This Agreement may be signed by the Signatories and Invited Signatories using photocopy, facsimile, or counterpart signature pages. TNF will distribute copies of all signed pages to the Signatories, Invited Signatories, and Consulting Parties, once the Agreement is executed. Execution of this Agreement by the TNF, the SHPO, and the ACHP, and implementation of its terms, evidence that the TNF has taken into account the effects of this undertaking on historic properties and has afforded the ACHP an opportunity to comment.

APPENDICES

A. Area of Potential Effects
B. Maps
C. Definitions
D. NAGPRA Plan
E. Key Staff Contact Information
F. Programmatic Agreement Process

SIGNATORY PAGE

**PROGRAMMATIC AGREEMENT
AMONG THE
USDA FOREST SERVICE TONTO NATIONAL FOREST,
ARIZONA STATE HISTORIC PRESERVATION OFFICER,
THE ADVISORY COUNCIL ON HISTORIC PRESERVATION,
REGARDING
COMPLIANCE WITH THE NATIONAL HISTORIC PRESERVATION ACT
ON THE RESOLUTION COPPER PROJECT
AND SOUTHEAST ARIZONA LAND EXCHANGE
NEAR SUPERIOR, ARIZONA**

USDA Forest Service, Tonto National Forest

By: ____

Printed Name: ____________________________________

Title: ____

Date: ____

SIGNATORY PAGE

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AND SOUTHEAST ARIZONA LAND EXCHANGE
NEAR SUPERIOR, ARIZONA**

Arizona State Historic Preservation Officer

By: ____

Printed Name: ____

Title: ____

Date: ____

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AND SOUTHEAST ARIZONA LAND EXCHANGE
NEAR SUPERIOR, ARIZONA**

The Advisory Council on Historic Preservation

By: ____

Printed Name: _______________________________________

Title: ____

Date: ____

INVITED SIGNATORY PAGE

PROGRAMMATIC AGREEMENT
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USDA FOREST SERVICE TONTO NATIONAL FOREST,
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AND SOUTHEAST ARIZONA LAND EXCHANGE
NEAR SUPERIOR, ARIZONA

Resolution Copper Mining, LLC

By: ____

Date: ____

INVITED By: ____________________________________

Printed Name: ____________________________________

Title: ____

Date: ____

INVITED SIGNATORY PAGE

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NEAR SUPERIOR, ARIZONA

Arizona State Land Department

By: ______________________________________

Date: ______________________________________

INVITED By: ______________________________________

Printed Name: ______________________________________

Title: ______________________________________

Date: ______________________________________

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AND SOUTHEAST ARIZONA LAND EXCHANGE
NEAR SUPERIOR, ARIZONA**

U.S. Department of the Interior, Bureau of Land Management

By: ____

Date: ____

INVITED By: ___________________________________

Printed Name: ____________________________________

Title: ____

Date: ____

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AND SOUTHEAST ARIZONA LAND EXCHANGE
NEAR SUPERIOR, ARIZONA

United States Army Corps of Engineers, Los Angeles District

By: ____

Date: ____

INVITED By: ___________________________________

Printed Name: ____________________________________

Title: ____

Date: ____

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AND SOUTHEAST ARIZONA LAND EXCHANGE
NEAR SUPERIOR, ARIZONA**

Arizona State Museum

By: ____________________________________

Date: ____________________________________

INVITED By: ______________________________

Printed Name: ______________________________

Title: ____________________________________

Date: ____________________________________